

3. SITE EVALUATION AND SCORING

The principal objective of the PA is to evaluate potential hazards to determine if further action at the site is necessary. EPA officials make a decision regarding site disposition and SI priority based on the PA evaluation of the potential threat the site may pose to human health and the environment. This section describes the process and requirements to evaluate and score sites at the PA stage of investigation:

- ! Section 3.1 discusses the importance of professional judgment to evaluate the likelihood of hazardous substance releases and exposure of targets to released substances, particularly to apply available analytical data.
- ! Section 3.2 describes the task of site, source, and waste characterization as a fundamental prerequisite to pathway evaluation and site scoring.
- ! Sections 3.3 through 3.6 provide specific guidance and instruction to evaluate and score the ground water, surface water, soil exposure, and air pathways using standard PA scoresheets.

A copy of the PA scoresheets is provided as Appendix A. The scoresheets package functions as a self-contained workbook providing all the basic tools to apply collected data and develop a PA score. The scoresheets package contains worksheets, factor value tables, scoring forms, and brief instructions. Sections 3.2 through 3.6 provide guidance that directly addresses the scoresheets and also applies to the PA-Score computer program (Section 4.3.2).

3.1 IMPORTANCE OF PROFESSIONAL JUDGMENT

Most of the factors that make up the PA are evaluated quantitatively by determining amounts, sizes, distances, and so forth. However, other factors -- those that relate to releases of hazardous substances from the site and the likelihood that specific targets may be exposed to released substances -- must often be evaluated qualitatively during the PA, by applying "professional judgment."

To know whether a release has occurred and whether specific targets have been exposed requires analytical sampling data detecting hazardous substances onsite and showing the presence or absence of hazardous substances in environmental media and at targets. This requires a sufficient number of samples, of sufficient quality, to show that any substances found are present above background levels and are present as a result of activity at the site. However, sampling is not generally performed during the PA, and comprehensive sampling data are not usually available from owner/operator or regulatory agency files for PA sites. This poses a dilemma for the PA investigator. Compounding the dilemma is the fact that, due to the structure of HRS and PA factor values, targets exposed to hazardous substances are weighted many times more heavily than targets not exposed, and for targets to be exposed, a hazardous substance must be released from the site.

3.1.1 Applying Existing Analytical Data

As an initial site investigation consisting primarily of a review of existing information about the site and a comprehensive study of targets, acquiring site-specific analytical data through environmental sampling is generally not within the scope of the PA. Such data may be available in site files and company records if routine company monitoring, a contracted site investigation, State or local Department of Health investigations, or emergency action has occurred. In most cases, however,

the site will not have been sampled in the past. When sampling data are available for a PA site, they must be examined carefully with respect to their suitability for drawing conclusions about hazardous substance releases and exposure of targets.

While there can be many advantages to having sample results at the PA to provide specific details about the identity, concentration, and areal distribution of hazardous substances, there are also many pitfalls in relying on such data, because:

- ! Previous sampling efforts may not have been conducted for purposes that are compatible with Superfund site assessment objectives (i.e., the need to identify hazardous substances, releases, and exposed targets).
- ! Previous sampling may not have been extensive enough to fully characterize the site and the possibility of a release (e.g., number and placement of sampling locations, depth of monitoring wells).
- ! Laboratory protocols and standards may not be known (e.g.: QC/QA procedures; limited analysis, rather than full-spectrum Target Compound List (TCL) analysis).
- ! Conditions may have changed since the site was last sampled (e.g., substances may have been released, migration may have spread, additional waste disposal may have occurred).

For these reasons, existing analytical data for PA sites should be very carefully reviewed to ensure that they do not lead to false negative conclusions. The fundamentals of an appropriate sampling strategy specific to the site, and specific to the needs of the Superfund site assessment program, will be formulated by you for sites that appear to warrant further investigation through an SI.

Interpret analytical data with caution and be aware of their limitations.

Analytical data indicating that hazardous substances are present in environmental media (ground water, surface water, surface water sediments, soil, or air) onsite, directly offsite, or at a particular target can be used to support a hypothesis that hazardous substances have been released from the site and/or that specific targets have been exposed, regardless of considerations relating to data quality, attribution of substances to site operations, or concentrations relative to background levels. In such cases, analytical indications are sufficient to support the hypothesis; it is not necessary to definitively demonstrate that a problem exists.

Analytical data can also be used to support hypotheses that no release has occurred and that targets have not been exposed, but the analytical data themselves should not generally be the sole or principal consideration leading to the hypothesis. For the reasons outlined above, existing analytical data indicating that a particular site, source, target, or sample is "clean" or contains hazardous substances below background levels must be viewed with caution. Applying existing analytical data as the principal support for hypotheses that rule out the occurrence of releases and the exposure of targets requires that the data definitively demonstrate that a problem does not exist; indications alone are not sufficient unless convincingly supported by other evidence.

In some cases, existing analytical data may be sufficiently reliable to confidently rule out the occurrence of releases and exposure of targets, and to confidently characterize the hazardous substances associated with the site. Refer to Section 5.3 for further discussion on how to apply such data.

Summarize any available analytical data on page 2 of the PA scoresheets under "Probable Substances of Concern." In particular, identify the sample media and locations, and list the

substances detected in source, environmental, and target samples, along with their corresponding maximum concentrations.

3.1.2 Applying Professional Judgment

If suitable analytical data are not available during the PA, you must apply professional judgment to evaluate the occurrence of releases and the presence of exposed targets. This is a somewhat intuitive process which relies on accumulated professional expertise and specific knowledge of characteristics and conditions of the site, its surroundings, and targets.

Critical PA professional judgments take the form of hypotheses that: (1) a release of a hazardous substance is or is not suspected to have occurred; and (2) specific targets are or are not suspected to have a relatively high likelihood of exposure to released substances. Targets likely to be exposed are termed "primary targets," while others are called "secondary targets."

Formulating appropriate hypotheses on these points is the essence of professional judgment. To assist in this process, "Criteria Lists" present a series of questions relating to the site, its surroundings, pathway characteristics, and targets. Their purpose is to get you thinking about the types of site-specific characteristics and conditions that may favor the release of hazardous substances and their migration to specific targets. The Criteria Lists are included in the PA scoresheets. Detailed discussion of pathway-specific Criteria Lists and guidance to apply them are presented for each pathway in Sections 3.3 through 3.6.

In general, it is appropriate to hypothesize the presence of primary targets and/or the occurrence of suspected releases when:

- ! Available analytical data indicate a potential problem.
- ! In the absence of analytical data, qualitative information indicate a potential problem.

Hypothesizing the absence of primary targets (secondary targets only) and no suspected release is generally appropriate when:

- ! Analytical data alone demonstrate there is no problem.
- ! Analytical data coupled with other, qualitative information supports a conclusion that there is no problem.
- ! In the absence of analytical data, qualitative information supports a conclusion that there is no problem.

When you have completed the PA, you will have a set of hypotheses regarding releases and targets. If the site advances to an SI, these hypotheses will form the foundation for the SI sampling plan. Most SI samples will be collected to test these hypotheses; the resulting analytical data will support either accepting or rejecting each hypothesis.

Always remember that when professional judgment is required to formulate hypotheses, it is important not to underestimate the potential threat. While it should be possible to collect sufficient information to support a clear professional judgment about the likelihood of a release and the condition of targets, when in doubt it is best to err on the side of caution and conclude that specific targets are affected and/or that a release has occurred. By not underestimating the potential threat, the worst outcome is that an SI will be conducted, the results of which may show that the threat is, in fact, relatively low and a NFRAP decision is appropriate. On the other hand, if the threat is underestimated at the PA, the worst outcome is that a PA NFRAP decision is made for a site that should have undergone an SI, that releases have occurred, and that targets (and possibly

human health) have been affected; these facts would remain undetected because the site was prematurely designated as NFRAP.

3.2 SITE, SOURCE, AND WASTE CHARACTERIZATION

A fundamental requirement of the PA is to describe the site, both physically and in terms of operational history. The first step is to access CERCLIS to obtain basic descriptive information about the site. CERCLIS can often provide the official site name, site identification number, street address, geographic coordinates, and other basic information (Section 2.1.1). Be aware that, because no field verification occurs prior to CERCLIS entry, information obtained from CERCLIS must be independently verified as part of your investigation. Record basic descriptive information on the cover page of the PA scoresheets and page 1 of the PA data summary form (Appendix D).

Determine the location of the site within the State and obtain the appropriate USGS 7.5-minute quadrangle topographic maps. Geographic coordinates of the site are sometimes lacking from the CERCLIS printout or are accurate only to the nearest minute. Always verify the coordinates obtained from CERCLIS by determining them yourself. Use EPA's standard operating procedure (SOP; Appendix E) to determine latitude and longitude coordinates by linear interpolation from the topographic map to within 0.5 second precision. Attach completed SOP worksheets as a reference to your PA narrative report (Section 4.2).

Suggestions on how to pursue other general descriptive information are offered in the following subsections. Additionally, it is essential to collect qualitative (descriptive) and quantitative (to the extent it can be approximated) information about wastes associated with the site. Technical data about sources and quantity of wastes in each source are critical to site assessment; obtaining this information is also addressed in the following subsections.

Pages 1 through 4 of the PA scoresheets provide space to present general site and source information. Your PA narrative report (Section 4.2) should contain similar summary information. Specific elements include:

- ! Official site name.
- ! CERCLIS identification number.
- ! Location: street address, city, county, State.
- ! Geographic coordinates: latitude/longitude; township, range, section.
- ! Owner/operator names, addresses, telephone numbers.
- ! Type of ownership: Federal, State, Indian, county, municipal, private.
- ! Years of operation.
- ! Regulatory involvement: permits, violations.
- ! Type of facility: manufacturing, waste disposal, storage, recycling, etc.
- ! Description of operations.
- ! History of methods of hazardous substance disposal, storage, or handling.
- ! Probable source types.
- ! Types of wastes present, probable substances of concern.
- ! Description of prior spills.
- ! Summary of existing samples and analytical data (if any).
- ! Reference and summary of manifests or waste records.
- ! Containment of wastes: secondary structures, procedures, monitoring.
- ! Mass, volume, or areal size of sources or volume of spills.
- ! Emergency or removal actions.
- ! Important resources and environments on or near the site.

3.2.1 Site Description and Source Characterization

A physical and operational description of the site can be obtained through file searches, interviews, and site reconnaissance (see Section 2). Page 2 of the PA scoresheets provides space to summarize this information.

General Site Description

Definition: Site -- The area consisting of the aggregation of sources, the areas between sources, and areas that may have been contaminated due to migration from sources; site boundaries are independent of property boundaries.

Examine existing file information in the Regional EPA and State environmental agency offices (Section 2.3). Identify the site owner and operator (individual, organization, or company), address, and telephone number. Note that the "owner" and the "operator" may be two different parties. Depending on Regional guidance, you may want to verify this information by contacting a representative of the facility owner or operator.

Files at EPA and State environmental agency offices may yield information about current and previous operator activities, site history, regulatory and permitting actions, etc. By examining files at the facility itself (during an onsite reconnaissance, for example), you may be able to obtain engineering plans or field layout diagrams showing buildings, structures, roads, and waste handling areas on the site. These can be very useful in physically characterizing the site and providing insights into its operational history. For each PA, whether such materials are available or not, you also need to view and photograph the site during your reconnaissance to document current conditions (see Section 2.5).

During the site reconnaissance, measure or estimate dimensions to develop an accurate portrayal of areas where waste disposal activities may have occurred. However, do not attempt to directly measure waste source areas without authorized access, a health and safety plan, and appropriate protective equipment, as discussed in Section 2.5. Determine dimensions in feet and area in square feet or acres. Note that dimensions may have changed over time, as facility operations expanded or declined, or as portions of the property were acquired or sold. Recall the definition of "site" and be careful to delineate as fully as possible any areas that may qualify as part of the site, regardless of current conditions, fences, boundaries, or ownership. In addition, identify any adjacent or nearby property owned or leased by the site owner/operator. Investigate the dates or years of operation, and identify current operational status. If the site is active, determine or estimate the number of workers employed. Identify the type of facility -- manufacturing, mining, coal gasification, retail, landfill, salvage, and so forth -- and the main site activities and operations, both past and present.

Source Identification and Characterization

Summarize waste treatment, storage, or disposal activities that have or may have occurred both in the past and at present; note if these activities are documented or alleged. It is especially important to identify the specific areas where waste disposal, deposition, storage, or handling may have occurred -- these represent the sources that you evaluate for waste quantity (Section 3.2.2).

Definition: Source -- An area where a hazardous substance may have been deposited, stored, disposed, or placed. Also, soil that may have become contaminated as a result of hazardous substance migration. In general, however, the volumes of air, ground water, surface water, and surface water sediments that may have become contaminated through migration are not considered sources.

A site may involve one or many types of sources such as surface impoundments, waste piles, municipal landfills, industrial landfills, industrial dumps, open dumps, above ground tanks, underground tanks, land treatment areas, sludge spreading areas, drum and container storage areas, spill areas, burn areas, etc. Identify all potential sources, their types, and dimensions (to the extent they can be measured or estimated). Sources are classified by physical structure (e.g., impoundment, landfill, tanks, containers) or by describing how the wastes have come to be deposited (e.g., pile, contaminated soil). If possible, also investigate source containment practices and type, volume, and physical state of wastes. Source types are described in Table 3-1, which includes an "other" source type for sources that clearly do not fit any other description.

Sources can be delineated and characterized through visual inspection during site reconnaissance; interviews with facility representatives, employees, or neighbors; and file searches (especially those at the facility itself) for disposal records, waste manifests, and waste sampling data. Another useful reference is aerial photography (see Section 2.4.4). Historical air photos may identify sources that are no longer discernible on the ground due to physical changes to the facility or surrounding topography. Manifests listing types and quantities of hazardous waste materials transported or deposited may be available for periods after 1980, when this type of record-keeping became mandatory. Some types of permit applications, including National Pollutant Discharge Elimination System (NPDES) permits, may also contain information about waste composition and quantity.

If information or data exist for previous sampling at the site, prepare a summary table and attach it to the PA scoresheets. For each sample, indicate the medium sampled, sample location, hazardous substances detected, concentrations, and analytical detection limits. On page 2 of the PA scoresheets, under "Probable Substances of Concern," briefly discuss the conclusions of previous sampling episodes and relate these findings to specific hazardous substances or compounds suspected to be present at the site. Discuss whether sampling detected any areas of onsite contamination or evidence of offsite migration via a release to ground water, surface water, or air.

Pathway Considerations

In addition to site history, physical characteristics of the site, and source characteristics, also identify any significant resources or features pertinent to the ground water, surface water, soil exposure, and air pathways. Note ground water monitoring or drinking water wells on or near the site. Determine if portions of the site are located in surface water. Describe surface water bodies and identify residences, schools, or sensitive environments on or adjacent to the site.

Table 3-1
Source Type Descriptions

Landfill: an engineered (by excavation or construction) or natural hole in the ground into which wastes have been disposed by backfilling, or by contemporaneous soil deposition with waste disposal, covering wastes from view.

Surface Impoundment: a topographic depression, excavation, or diked area, primarily formed from earthen materials (lined or unlined) and designed to hold accumulated liquid wastes, wastes containing free liquids, or sludges that were not backfilled or otherwise covered during periods of deposition; depression may be dry if deposited liquid has evaporated, volatilized or leached, or wet with exposed liquid; structures that may be more specifically described as lagoon pond, aeration pit, settling pond, tailings pond, sludge pit, etc.; also a surface impoundment that has been covered with soil after the final deposition of waste materials (i.e., buried or backfilled).

Drums: portable containers designed to hold a standard 55-gallon volume of wastes.

Tanks and Non-drum Containers: any stationary device, designed to contain accumulated wastes, constructed primarily of fabricated materials (such as wood, concrete, steel, or plastic) that provide structural support; any portable or mobile device in which waste is stored or otherwise handled.

Contaminated Soil: soil onto which available evidence indicates that a hazardous substance was spilled, spread, disposed, or deposited.

Pile: any non-containerized accumulation above the ground surface of solid, non-flowing wastes; includes open dumps. Some types of piles are: Chemical Waste Pile -- consists primarily of discarded chemical products, by-products, radioactive wastes, or used or unused feedstocks; Scrap Metal or Junk Pile -- consists primarily of scrap metal or discarded durable goods such as appliances, automobiles, auto parts, or batteries, composed of materials suspected to contain or have contained a hazardous substance; Tailings Pile -- consists primarily of any combination of overburden from a mining operation and tailings from a mineral mining, beneficiation, or processing operation; Trash Pile -- consists primarily of paper, garbage, or discarded non-durable goods which are suspected to contain or have contained a hazardous substance.

Land Treatment: landfarming or other land treatment method of waste management in which liquid wastes or sludges are spread over land and tilled, or liquids are injected at shallow depths into soils.

Other: a source that does not fit any of the descriptions given above; examples include contaminated building, ground water plume with no identifiable source, storm drain, dry well, and injection well.

Sample Site Description

An example of the type of brief site description to record on page 2 of the PA scoresheets follows:

Site X is an inactive 4.5-acre fabricated metal products manufacturing facility located in an industrial park which has been developed on former pasture land since the early 1960's. The facility was built in 1966. Through 1979, the main manufacturing process was candlestick electroplating, which generated lead-based paint sludge, chromium compounds, scrap metals, and various solvents. Wastes were discharged to three surface impoundments. From 1975 through 1979, 2 acres of the facility were also used to salvage and restore chrome automobile bumpers. In 1987, the State Department of Health (DOH) investigated citizen complaints about "suspicious" liquid wastes pooled in impoundments on the abandoned property. Samples of soil near the surface impoundments revealed lead (231 mg/kg) and Cr ⁺³ (12,400 mg/kg). According to DOH records, samples for VOC analysis were also collected, but the results could not be found in the file. DOH secured the site with cyclone fencing in 1988.

Surrounding businesses obtain drinking water and process water from a single well that serves all facilities in the park. The well is located approximately 900 feet northwest of the site. The nearest residence is approximately 3/4 mile to the east of the industrial park.

A drainage ditch originates on the site and follows the western perimeter; the ditch passes several other industrial establishments before entering a marshy area approximately 2,000 feet north of the site. Little Creek emerges from the marsh and flows 2.1 miles before entering Big River.

Site Sketch

Sketch the site on page 3 of the PA scoresheets. Indicate all pertinent features, including all potential waste sources, buildings, dwellings, access roads, parking areas, drainage patterns, ponded water, water bodies, stressed vegetation, barren areas, wells, sensitive environments, and so forth. If necessary, enlarge areas of the sketch to illustrate details of specific conditions. Your sketch should provide sufficient detail to locate critical pathway elements and to reference previous sampling locations (if available for the site). Note significant natural features as well as buildings and other structures. Appendix C includes an example site sketch for the PA narrative report, which may be included in the scoresheets.

3.2.2 Waste Quantity and Waste Characteristics

The heart of waste characterization during the PA is an estimation of the quantity of potential wastes associated with all sources at the site. Use the information gathered about historical and current waste handling procedures, potential sources, waste amounts, and source dimensions, to characterize as completely as possible the waste quantities related to the facility.

Due to the limited scope of the PA, your evaluation of waste characteristics will never be truly complete. Not until further study has identified, characterized, measured, sampled, analyzed, and documented all sources can the quantity and properties of the hazardous wastes at the site be fully known. Consequently, the following assumptions regarding sources and wastes typically apply for the PA:

- ! Every potential source is large enough to actually or potentially impact human and environmental resources, regardless of size.
- ! It is very likely that hazardous substances present in wastes related to the site are extremely toxic, mobile, persistent, and able to accumulate in tissues.
- ! The total quantity of hazardous wastes associated with the site are eligible for evaluation even if, at any time in the history of the facility, wastes have been removed. (Exceptions to this assumption may occur, on a site-by-site basis, for certain types of qualifying removals. For further details, see EPA publication 9345.103FS, "The Revised Hazard Ranking System: Policy on Evaluating Sites After Waste Removals.")
- ! The total quantity of waste present produces at least the PA minimum waste characteristics factor category score (discussed later in this section).

Tiered Approach to Evaluate Waste Quantity (WQ)

For each source, waste quantity may be evaluated by one or all of four different measures called "tiers": constituent quantity, Wastestream quantity, source volume, source area. PA Table 1 a (page 5 of the PA scoresheets) is divided into these four horizontal tiers. The amount and level of detail of the information available determine which tier(s) to use for each source. For each source, evaluate as many of the four tiers as you have data to support and select the result that gives the highest waste characteristics factor category score.

Hazardous constituent quantity refers to the mass of pure hazardous substances present in a source. Detailed disposal records and/or detailed analytical data are necessary to evaluate hazardous constituent quantity; this level of information is not often available for PA sites.

Wastestream quantity refers to the total mass of each particular type of waste present in the source. For example, a trench that received a known number of drums of spent solvent, a known mass of lead batteries, and a known volume of creosote-treated railroad ties could be evaluated on the basis of these three distinct wastestreams by converting each to mass and summing (note that this source would also be evaluated on the basis of volume and area if depth and surface dimensions were known or could be estimated). Detailed disposal records, which are not often available, are needed to properly evaluate wastestream quantity.

If records are available to support hazardous constituent and/or wastestream quantity calculations (in pounds), apply the following conversions:

$1 \text{ cubic yard} = 4 \text{ drums} = 200 \text{ gallons} = 1 \text{ ton} = 2,000 \text{ pounds}$

Sources are most commonly evaluated at PA sites on the basis of volume or area. Measuring or estimating source dimensions has been previously discussed (Sections 2.3, 2.4, 2.5, and 3.2.1); onsite reconnaissance, owner/operator files, facility maps or engineering plans, and aerial photographs are all good approaches to determine source dimensions. When estimating source dimensions, it is a good practice to extrapolate those dimensions to cover the full area where you suspect hazardous substances may have been deposited and to include the total possible area of soil that may have been contaminated by substances associated with the sources. Recall the definition of "source" and, if you suspect that areas between sources may also be contaminated, evaluate those areas as separate sources as well.

General Instructions to Score Waste Characteristics (WC)

Turn to PA Table 1a (page 5 of the PA scoresheets) and note the four horizontal tiers. In the volume and area tiers, the left-most column lists a variety of source types. Moving horizontally across the table for each source type, the next three columns provide volume and area ranges for each source type. Each range corresponds to a waste characteristics factor category score (WC) given at the top of the column (18, 32, or 100).

For a site with a single source, assign WC for the appropriate size range of the appropriate source type. Evaluate as many tiers as you have data to support, and select the highest resulting WC.

Example: Single-source site

Source type:	Landfill
Constituent quantity:	Not available
Wastestream quantity:	Not available
Volume:	7 million ft ³ ; WC = 32
Area:	250,000 ft ² ; WC = 18

Site WC = 32, the highest result among the tiers evaluated

For a site with multiple sources, convert each source measure to its appropriate units, and divide the result as indicated in the right-most column of PA Table 1a; this yields a waste quantity (WQ) value for each source. Sum the highest WQ values, among the tiers evaluated, for all sources. From PA Table 1b, assign WC corresponding to the range into which the summed WQ falls.

Example: Multiple-source site

Source type:	Landfill
Constituent quantity:	Not available
Wastestream quantity:	Not available
Volume:	7 million ft ³ ; $WQ = 7 \text{ million} \div 67,500 = 103.7$
Area:	250,000 ft ² ; $WQ = 250,000 \div 3,400 = 73.5$
Source type:	Drums
Constituent quantity:	Not available
Wastestream quantity:	750 drums x 50 gal/drum x 10 lb/gal 375,000 lb $WQ = 375,000 \div 5,000 = 75$
Volume:	750 drums; $WQ = 750 \div 10 = 7.5$
Area:	Not evaluated

Summing the highest WQ for each source yields a site $WQ = 103.7 + 75 = 178.7$

From PA Table 1b, site WC = 32

Evaluating constituent quantity and/or wastestream quantity is no different from volume and area evaluations, except that mass (in pounds) is always the unit of measure regardless of source type.

With that as a brief explanation of the structure and use of PA Tables 1a and 1b, general instructions for evaluating WQ and determining WC for sites having a single source and sites with multiple sources are summarized below.

For sites with only one source:

1. Identify source type (Table 3-1).
2. Examine all waste quantity data available.
3. Estimate the mass or dimensions of the source.
4. Determine which quantity tiers to use based on the source information available see PA Table 1a and page 45 of this guidance).
5. Convert source measurements to the appropriate units for each tier evaluated.
6. Identify the range into which the source falls for each tier evaluated (PA Table 1a).
7. Determine the highest waste characteristics factor category score (WC) obtained for any tier (18, 32, or 100, at the top of PA Table 1a columns).
8. Use this WC for all pathways (exceptions are noted in Sections 3.3.3, 3.4.3, and 3.6.3).

For sites with multiple sources:

1. Identify each source type (Table 3-1).
2. Examine all waste quantity data available for each source.
3. Estimate the mass or dimensions of each source.
4. Determine which quantity tiers to use for each source based on the information available (see PA Table 1a and page 45 of this guidance).
5. Convert source measurements to the appropriate units for each tier evaluated for each source.
6. Divide the measurement for each source as indicated in the right-most column of PA Table 1a. Identify the highest resulting waste quantity value (WQ), among the tiers evaluated, for each source. Sum the highest WQs for all sources.
7. Use PA Table 1b to assign the waste characteristics factor category score (WC) for the range into which the summed WQ falls.
8. Use this WC for all pathways (exceptions are noted In Sections 3.3.3, 3.4.3, and 3.6.3).

Scoring Waste Characteristics (WC) for Specific Source Types

Procedures to quantitatively evaluate each source type using PA Tables 1a and 1b follow:

Hazardous Constituent (pure hazardous substance)

Determine mass for each constituent. If necessary, convert volume to pounds. Sum all constituent mass values. If total constituent mass is less than or equal to 100 pounds, assign a waste characteristics factor category score (WC) of 18. If total constituent mass is greater than 100 and less than 10,000 pounds, assign WC 32; greater than 10,000 pounds, assign WC 100.

Constituent wastes are hazardous substances in pure liquid, solid, or (less commonly) gaseous form. The mass of constituents can be calculated from volume. Some examples of applying constituent data are:

- ! For 16 25-gallon containers and 20 drums labeled carbon tetrachloride (pure substance), determine the total volume in gallons (assume a 50-gallon volume for drums not otherwise specified) and convert to mass (10 pounds per gallon). The resulting quantity of hazardous constituent is 14,000 pounds $((16 \times 25) + (20 \times 50)) \times 10$, which yields a PA waste characteristics score of 100.
- ! For a single drum of unspecified volume and labeled 30 percent aldicarb (a pesticide), multiply 50 gallons \times 10 pounds per gallon \times 0.3, yielding 150 pounds for constituent waste quantity.
- ! 50,000 pounds of sludge with a representative lead concentration of 300 mg/kg results in a constituent quantity of 15 pounds of lead.
- ! For 5 million yd^3 of mine tailings with representative arsenic and copper concentrations of 24.4 and 47.6 mg/kg, respectively, first convert volume to mass: $5 \text{ million } \text{yd}^3 \times 1 \text{ ton}/\text{yd}^3 = 5 \text{ million tons} = 10 \text{ billion lb}$. Next, convert constituent concentrations to mass: 24.4 mg/kg in 10 billion lb of tailings yields 244,000 lb of arsenic; 47.6 mg/kg in 10 billion lb of tailings yields 476,000 lb of copper. The constituent waste quantity is the sum: $244,000 + 476,000 = 720,000 \text{ lb}$; WC is 100.
- ! A report or manifest showing that 120 pounds of powdered DDT concentrate were transported from an agricultural research facility and disposed at the site could also be used as evidence of constituent quantity.

Hazardous Wastestream (known quantity of a single type of waste)

Determine mass of each wastestream. If necessary, convert volume to pounds. If there is only one wastestream and the wastestream quantity is less than 500,000 pounds, assign WC 18; if greater than 500,000 and less than 50 million pounds, assign WC 32; if greater than 50 million pounds, assign WC 100.

If there is more than one wastestream, divide each wastestream mass by 5,000 and sum the results to obtain a wastestream WQ. Add the wastestream WQ to other partial WQ values calculated for sources at the site, and assign WC from PA Table 1b.

Drum Volume (for drums not suspected or labeled as containing pure or undiluted hazardous substances) For standard 55-gallon drums, assume the volume of each is 50 gallons (allowing a 5-gallon headspace). If there are less than 1,000 drums (50,000 gallons) at the site, WC is 18; if

greater than 1,000 and less than 100,000 drums (50,000 gallons < V < 5 million gallons), WC is 32; if more than 100,000 drums, or greater than 5 million gallons, WC is 100.

If there are other sources, along with drums, divide the total number of drums by 10 to determine the drum WQ value. Add the drum WQ to the other source WQ values calculated for the site, and assign WC from PA Table 1b.

Tank and Non-drum Container Volume

For a source consisting of tanks or containers other than drums, sum the volumes of the containers (in like units of measure) and convert the total volume to gallons. Assign WC a value of 18 if the total volume is less than or equal to 50,000 gallons, WC 32 if volume is greater than 50,000 and less than 5 million gallons, and WC 100 if volume is greater than 5 million gallons.

If there are other sources, along with tanks or containers, divide the total non-drum volume (gallons) by 500 to determine the non-drum volume WQ value. Add the non-drum volume WQ to the other source WQ values calculated for the site, and assign WC from PA Table 1b.

Volume and Area Conversions

1 cubic yard = 27 cubic feet

1 acre = 43,560 square feet

Landfill Volume (length x width x depth) or (area x depth)

If surface area and depth of excavation for landfilling operations are known or can be estimated, calculate landfill volume in cubic yards. Landfill volume less than or equal to 250,000 yd³ receives a WC value of 18; greater than 250,000 and less than 25 million yd³ receives WC 32; and greater than 25 million yd³ receives WC 100.

If there are other sources, along with the landfill, divide the landfill volume (yd³) by 2,500 to determine the landfill volume WQ value. Add the landfill volume WQ to the other source WQ values calculated for the site, and assign WC from PA Table 1b.

Landfill Area (length x width)

Measure or estimate landfill surface area in square feet or acres. If the area is less than or equal to 340,000 ft² (7.8 acres), assign WC 18; if greater than 340,000 and less than 34 million ft² (780 acres), assign WC 32; if greater than 34 million ft² (780 acres), assign WC 100.

If there are other sources, along with the landfill, divide the landfill area (ft²) by 3,400 to determine the landfill area WQ value. Add the landfill area WQ to the other source WQ values calculated for the site, and assign WC from PA Table 1b.

Surface Impoundment Volume (length x width x depth) or (area x depth)

For a surface impoundment, whether wet, dry, buried, or backfilled, if area and depth are known or can be estimated, determine volume of the impoundment in cubic yards. If the volume is less than or equal to 250 yd³, WC is 18; if greater than 250 and less than 25,000 yd³, WC is 32, if greater than 25,000 yd³, WC is 100.

If there are other sources, along with the surface impoundment, divide the surface impoundment volume (yd³) by 2.5 to determine the surface impoundment volume WQ value. Add this WQ value to the other source WQ values calculated for the site, and assign WC from PA Table 1b.

Surface Impoundment Area (length x width)

Measure or estimate, in square feet, the area of the surface impoundment (whether wet, dry, backfilled, or buried). Assign WC 18 if the surface impoundment area is less than or equal to 1,300 ft²; 32 if area is greater than 1,300 and less than 130,000 ft²; and 100 if area is greater than 130,000 ft².

If there are other sources, along with the surface impoundment, divide the surface impoundment area (ft²) by 13 to determine the surface impoundment area WQ. Add this WQ value to the other source WQ values calculated for the site, and assign WC from PA Table 1b.

Contaminated Soil Volume (length x width x depth) or (area x depth)

If the volume of contaminated soil can be determined by measuring or estimating area and the depth to which hazardous substances are suspected to extend, convert the volume to cubic yards. If contaminated soil is the only source at the site, assign WC values for ranges of volume: 18 if volume is less than or equal to 250,000 yd³; 32 if greater than 250,000 and less than 25 million yd³; and 100 if greater than 25 million yd³.

If there are other sources, along with contaminated soil, divide the contaminated soil volume (yd³) by 2,500 to obtain a contaminated soil volume WQ. Add this WQ value to the other source WQ values calculated for the site, and assign WC from PA Table 1b.

Contaminated Soil Area (length x width)

Measure or estimate the surface area of contaminated soil (square feet or acres). Assign WC 18 if the area is less than or equal to 3.4 million ft² (78 acres); 32 if area is greater than 3.4 million and less than 340 million ft² (7,800 acres); and 100 if area is larger still.

If there are other sources, along with contaminated soil, divide the contaminated soil area (ft²) by 34,000 to obtain a contaminated soil area WQ. Add this WQ value to the other source WQ values calculated for the site, and assign WC from PA Table 1b.

Contaminated soil may be the result of spills, leaking containers, or direct disposal of solid or liquid hazardous wastes on the ground. You may hypothesize areas of contaminated soil from accounts of waste handling procedures, intentional spreading practices (with and without permits), fire records, known or alleged discharges, and similar evidence. You may also use evidence of stained soil, stressed vegetation or areas barren of vegetation, and available analytical data (if any) to estimate areas of contaminated soil.

Although many sites have contaminated soil, the quantity is rarely great enough to contribute significantly to the overall site WC factor category score, because so much (more than 250,000 yd³ or 78 acres) is required to achieve a WC above the PA minimum of 18. However, it remains important to identify and to note all areas of contaminated soil, because the distance from sources to targets can be a critical consideration for each pathway -- especially the soil exposure pathway.

Pile Volume

If you know or can estimate the volume of waste making up a source pile, convert units to cubic yards. Assign WC a value of 18 if the volume is less than or equal to 250 yd³, WC 32 if volume is greater than 250 and less than 25,000 yd³, and WC 100 if volume is greater than 25,000 yd³.

If there are other sources, along with the pile, divide the pile volume (yd^3) by 2.5 to determine the pile volume WQ value. Add the pile volume WQ to the other source WQ values calculated for the site, and assign WC from PA Table 1b.

Pile Area (land surface area under the pile)

Estimate the area under a source pile and express in square feet. Assign WC 18 if area is less than or equal to $1,300 \text{ ft}^2$; 32 if area is greater than 1,300 and less than $130,000 \text{ ft}^2$; and 100 if area is greater than $130,000 \text{ ft}^2$.

If there are other sources, along with the pile, divide the pile area by 13 to determine the pile area WQ value. Add the pile area WQ to the other source WQ values calculated for the site, and assign WC from PA Table 1b.

Other Volume

The "other" source type can only be selected for a source that clearly does not fit any of the other source type descriptions in Table 3-1, and can only be evaluated on the basis of volume. If you know or can estimate the volume of the source, convert units to cubic yards. Assign WC a value of 18 if the volume is less than or equal to 250 yd^3 , WC 32 if volume is greater than 250 and less than $25,000 \text{ yd}^3$, and WC 100 if volume is greater than $25,000 \text{ yd}^3$.

If there are additional sources, along with the "other" source, divide the "other" source volume (yd^3) by 2.5 to determine the source volume WQ value. Add the volume WQ to the additional source WQ values calculated for the site, and assign WC from PA Table 1b.

Land Treatment Area (length x width)

Measure or estimate, in square feet, the area of land treatment. Assign WC 18 if the area is less than $27,000 \text{ ft}^2$ (0.62 acres); 32 if area is greater than 27,000 and less than 2.7 million ft^2 (62 acres); and 100 if area is greater than 2.7 million ft^2 .

If there are other sources, along with the land treatment area, divide the land treatment area (ft^2) by 270 to obtain the land treatment area WQ value. Add this WQ value to the other source WQ values calculated for the site, and assign WC from PA Table 1b.

Concluding Note

Identify and describe each source in the space provided on page 4 of the PA scoresheets. Also show all source WQ and site WC calculations.

Remember to evaluate WQ for each source under as many tiers as you have data to support. Assign the highest resulting WQ to the source. If there is more than one source at the site, sum the assigned WQ values for each source to arrive at the site WQ. Assign WC on the basis of this total site WQ.

Do not assign any WC score other than 18, 32, or 100. The PA minimum WC is 18, which may be assigned if waste quantity information is lacking, incomplete, or minimal. Never assign a zero score to WC; if you can convincingly show that no CERCLA hazardous substances are or ever have been at the site, PA scoring may not be necessary (see Section 2.2.4).

The assigned WC is applied as the waste characteristics factor category score under all four pathways, except if primary targets are present. Sections 3.3.3, 3.4.3, and 3.6.3 discuss these exceptions on a pathway-by-pathway basis.

GROUND WATER PATHWAY

3.3 GROUND WATER PATHWAY

The PA evaluation of the ground water pathway requires you to consider and assign scores to factors in three factor categories: Likelihood of Release, Targets, and Waste Characteristics.

Evaluating likelihood of release requires you to hypothesize whether hazardous substances are likely to have migrated to ground water. When a release is not suspected, special considerations that enter into your scoring decision include the depth to the shallowest aquifer and the presence of karst terrain.

The principal threat under the ground water pathway is the threat posed to drinking water and to populations relying on ground water as their source of drinking water. Therefore, the targets evaluation is primarily concerned with identifying drinking water wells, and their associated populations, within the 4-mile target distance limit (radius) around the site.

The evaluation and score for the waste characteristics factor category (WC, Section 3.2.2) applies directly to the ground water pathway, as to all other pathways, except if primary targets are identified (Section 3.3.3).

Proper evaluation of the ground water pathway requires a general understanding of the local geology and subsurface conditions. Of particular interest is descriptive information relating to subsurface stratigraphy, aquifers, and ground water use.

Definition: Aquifer -- A saturated subsurface zone from which drinking water is drawn.

Publications of the USGS and State geological surveys are good sources for local and regional geologic information. Other local sources of information may include well drillers, well logs (possibly maintained by local or State government agencies), and university geology departments. Briefly describe the local geology, subsurface stratigraphy, aquifers, and aquifer uses within 4 miles of the site. Record this summary on page 6 of the PA scoresheets.

3.3.1 Likelihood of Release

Evaluating the Likelihood of Release factor category requires a professional judgment, based on site and pathway conditions, as to whether a hazardous substance is likely to have been released to ground water. Likelihood of Release is scored on the basis of one of two scenarios, "Suspected Release" or "No Suspected Release," either of which require you to make this professional judgment. Your judgment takes the form of a hypothesis that a release has or has not occurred. The formulation of your hypothesis is guided by the "Criteria List" (page 7 of the PA scoresheets).

Criteria List for Suspected Release to the Ground Water Pathway

The Criteria List helps guide the process of developing hypotheses about two very important aspects of the site: whether a hazardous substance is likely to have been released to ground water; and whether any drinking water wells are likely to be exposed to a hazardous substance as a result of a release. The Criteria List suggests a number of characteristics of the site and its environs to consider in reaching conclusions on these points. Answer the questions in the left-hand column of the Criteria List, which deal with a suspected release; the right-hand column, dealing with primary targets, is evaluated in connection with the Targets factor category (Section 3.3.2) if you conclude that a release to ground water is likely to have occurred.

Carefully consider each element on the Criteria List within the context of the site and its environs. Answers to every question on the list, however, are unlikely to be available for many sites. You need not spend excessive amounts of time trying to develop detailed information to respond to each question -- it is possible to arrive at sound hypotheses about suspected releases and their potential effects on targets without knowing answers to all questions on the list.

Also, keep in mind that because there is an infinite variety of site-specific circumstances, no list of this type could identify every characteristic that might apply to any specific site. The list, therefore, is by no means complete and the criteria making up the list are not prioritized in any way. Instead, these questions are meant to get you thinking about the types of site-specific conditions that need to be considered when formulating hypotheses about releases and the condition of targets. There are likely to be other site-specific criteria that apply to a particular site, and you are encouraged to think along these lines. If such additional considerations enter into your conclusions, identify them at the bottom of the list.

Answer the questions on the list by checking the appropriate box marked "yes," "no," or "unknown." In evaluating each question, rely on the total body of information you have obtained about the site and its environs through the course of your investigation -- file searches, desktop data collection, site reconnaissance, interviews, etc.

Answers to many of the individual questions are likely to be fairly self evident. The difficult part lies in drawing the final conclusion, which amounts to a hypothesis as to whether you suspect a release. This requires professional judgment and is a somewhat intuitive process that relies upon your accumulated professional expertise and specific knowledge of site and target characteristics. Note that the Criteria List is not a tally sheet requiring a majority of "yes" or "no" responses to reach a conclusion. You may hypothesize a suspected release on the basis of one or more characteristics that lead you to believe there is a relatively high likelihood that a hazardous substance has been released to ground water.

GROUND WATER PATHWAY LIKELIHOOD OF RELEASE

Suspected Release Considerations

Each item on the Criteria List for suspected releases to ground water is briefly discussed below.

Are sources poorly contained?

For many types of sources, proper containment to prevent hazardous substances from migrating to ground water requires engineered structures, such as double liners and a leachate collection system, that are inspected regularly and properly maintained. This level of containment for all sources is not often found at CERCLIS hazardous waste sites. Your response may be "yes" if wastes have been:

- ! Leaked, spilled, or spread on the ground.
- ! Buried underground.
- ! Deposited in trenches or impoundments in permeable soils.
- ! Deposited in sources lacking complete containment.

An example of conditions for a "no" response is: tanks on a well-maintained cement platform inside an intact building, protected from precipitation and run-on, with functioning runoff control should the containers leak or rupture.

Is the source a type likely to contribute to ground water contamination?

Many source types are likely contributors to ground water contamination because they are situated in or on the ground. Examples include underground tanks, landfills, surface impoundments or lagoons, and open dumps. The presence of liquid wastes in a source adds to the likelihood of migration. Sources less likely to contribute to ground water contamination might include sound above-ground tanks, drummed solid wastes, or sources inside buildings.

Is waste quantity particularly large?

Depending on the type of waste and its physical state, "large" is a relative term with respect to the potential for a release to ground water. In this context, a relatively small lagoon containing liquid wastes probably has more importance than a large pile of mine tailings. In general, however, any amount is considered "large" if it produces a waste characteristics factor category score (WC) of 32 or more.

Is precipitation heavy?

Heavy precipitation provides a driving force to carry hazardous substances through the soil to ground water. Total annual precipitation exceeding 40 inches or annual net precipitation exceeding 15 inches might be considered "heavy" precipitation. You can obtain this information from the "Climatic Atlas of the United States," published by the U.S. Department of Commerce, or from local weather stations.

Is the infiltration rate high?

A high infiltration rate means that surface soil conditions favor the rapid downward movement of water. The combination of heavy precipitation and high infiltration rate increases the likelihood of hazardous substances reaching ground water. Infiltration rates range from very high in gravelly and sandy soils to very low in fine silt and clayey soils. You can find out about

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soil types in the area of the site from the County Extension Office of the USDA Soil Conservation Service (SCS), or from soil survey maps published by the SCS for most counties in the nation.

Is the site located in an area of karst terrain?

In karst formations, ground water moves very rapidly through solution channels caused by dissolution of the rock material (usually limestone), which could facilitate migration of hazardous substances. See the discussion of karst conditions on pages 57 to 58 for more information.

Is the subsurface highly permeable or conductive?

Just as high infiltration rates indicate rapid movement of water through surface soils, highly permeable or conductive subsurface materials also favor downward movement of water that may transport hazardous substances. The presence of low-permeability materials or confining layers will impede this movement. Well logs, local geologic literature, or interviews with individuals knowledgeable about the geology of the area will help answer these questions.

Sands and gravels tend to be very conductive, as do highly fractured bedrock environments. The presence of lava tubes or mine drainage tunnels, or conditions of non-karst cavern porosity, also favor the rapid movement of ground water.

Is drinking water drawn from a shallow aquifer?

In the context of the PA, an aquifer is defined as "a saturated subsurface zone from which drinking water is drawn." Note the emphasis on ground water use in the definition. The shallower a source of drinking water, the higher the threat of contamination by hazardous substances. Information on well and aquifer depths can be obtained from well logs and by interviewing local water authorities, well drillers, and private well owners. Geologic literature on the area may also be useful. Determining depth to aquifer is discussed on pages 56 to 57.

Are suspected contaminants highly mobile in ground water?

The extent to which you can identify the hazardous substances present at a site is variable at the PA. For some sites, specific substances will be identifiable from available analytical data, file searches, or interviews during a site visit. At other sites, the general types of substances present may be inferred from knowledge about site operations. You should be able to generalize about the substances suspected to be present, and their relative mobility in ground water. Metals, for example, do not tend to be very mobile, while most liquids tend to be relatively highly mobile.

Does analytical or circumstantial evidence suggest ground water contamination?

"Circumstantial" implies a level of certainty below that of "proven fact," and this is sufficient for PA purposes. In this context, any condition that you find suspicious, and that indicates a possible contamination problem, can be considered circumstantial evidence. A few examples are:

- ! Analytical data provide indications of hazardous substances in ground water, regardless of whether you can specifically attribute those substances to the site.

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- ! Monitoring wells are present onsite.
- ! Nearby wells of any type have been closed for reasons you do or do not know.
- ! Users of nearby drinking water wells have complained to the Health Department about "funny tasting" water.

After answering these questions, and adding other considerations to the list, indicate your professional judgment as to the likelihood of a release of hazardous substances by checking "yes" or "no" next to the "Suspected Release?" question. Remember that this is a judgment call; you don't need a majority of "yes" responses -- in some cases, a single "yes" may be sufficient to suspect a release. Summarize the rationale for your hypothesis.

Special Considerations When a Release Is Not Suspected

If your evaluation of the Criteria List leads you to conclude that a release to ground water is not suspected, two specific considerations are important to assign the PA score for Likelihood of Release: depth to aquifer and presence of karst terrain. Both are included in the Criteria List, but are discussed in more detail here due to their importance when a release is not suspected.

Depth to Aquifer

Definition: Depth to Aquifer -- The vertical distance between the deepest point at which hazardous substances are suspected and the top of the shallowest aquifer that supplies drinking water.

Depth to aquifer can be used as an indicator of the likelihood of release of hazardous substances to ground water. Consider, for example, two hypothetical sites with similar characteristics, except that the depth to aquifer under Site A is relatively small (say, 50 feet), while the depth to aquifer under Site B is relatively great (say, 150 feet). You might expect Site A to have a higher likelihood of hazardous substances migrating to ground water.

Three pieces of information are required to evaluate depth to aquifer:

- (1) An estimate of the deepest point at the site at which you suspect hazardous substances may be located.
- (2) An estimate of the depth below land surface (bls) to the top of the shallowest aquifer that supplies drinking water.
- (3) Confirmation that the aquifer you are measuring to is used to provide drinking water.

Usually, estimating the deepest point at which hazardous substances are suspected to be located is a function of the types of sources at the site. For example, at a landfill the deepest point of hazardous substances could be estimated as the depth (bls) of the landfill itself. Similarly, the maximum depth of a surface impoundment or lagoon might be used. For waste piles, drum storage areas, or other above-ground sources, the deepest point of hazardous substances might be the ground surface itself.

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If previous site investigations (by a State agency or the site owner, perhaps) involved environmental sampling, the resulting analytical data could be used to estimate the deepest point of hazardous substances. Boreholes, test pits, or other excavations may have revealed subsurface contamination at known depths, or monitoring well samples might indicate hazardous substances in ground water. In the latter case, the deepest point of hazardous substances could be estimated as the top of the well screen. Be aware, however, that PA sites with available subsurface analytical data are not common; in most cases, you will have to rely on other types of information.

For sources that extend below the ground surface, but whose actual depth cannot be estimated, you may assume depth of waste deposition to be 6 feet.

Don't get hung up on trying to pinpoint the depth of the deepest hazardous substances. Unless one or more sources are actually deep in the ground (for example, an underground storage tank or an excavated landfill), there's not likely to be a great difference between the true depth of hazardous substances, a default depth of 6 feet, or the ground surface. The depth of the aquifer itself is generally the more important concern.

You can most directly determine the depth to the top of the shallowest aquifer by interviewing local water supply officials. This can be done via telephone from your office, or during a meeting as part of your offsite reconnaissance. Other sources may include the local Health Department, where the County Sanitarian or similar official is responsible for testing the potability of well water, and local well drillers. Since aquifers are usually laterally extensive, and because variations in surface topography affect the below-land-surface depth of the aquifer, use a depth estimate that is local to the site. It need not be the depth specifically under the site, but it shouldn't be a depth from more than 2 miles away. Record the depth to aquifer in the "Pathway Characteristics" box on the ground water pathway scoresheet (page 8 of the PA scoresheets).

Remember that the aquifer whose depth you are evaluating must be the shallowest aquifer that supplies drinking water to wells within the 4-mile target distance limit. Be sure that the people you contact regarding aquifer depths understand this distinction, and that you include confirmation of use in your written documentation.

In addition to interviews as discussed above, other primary sources of information on local hydrogeology, water supply, and aquifer use include the geologic literature published by USGS and similar State agencies. Aquifer depths can also often be determined from well logs filed with local or State agencies, or obtained from a local drilling company.

Karst Terrain

"Karst" is a kind of terrain with characteristics of relief and drainage arising from a high degree of rock solubility. The majority of karst conditions occur in limestone areas, but karst may also occur in areas of dolomite, gypsum, or salt deposits. Features associated with karst terrain may include irregular topography, abrupt ridges, sinkholes, caverns, abundant springs, and disappearing streams. Well-developed or well-integrated surface drainage systems of streams and tributaries are generally lacking.

The presence of karst is an important aspect of the environment around the site because the PA treats karst areas somewhat differently from non-karst areas. Compared to other geologic formations, karst formations and karst aquifers transmit larger quantities of water and do so much more rapidly. Water in karst aquifers moves through solution channels in rock material; water in other types of aquifers moves through pores or cracks, or along fractures and faults. The

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comparison is somewhat akin to water movement through a pipe vs. a sponge. Thus, hazardous substances associated with a site located in karst terrain are more likely to reach ground water than substances from a site with similar conditions located in a non-karst area. Once in ground water, hazardous substances in a karst aquifer are also apt to travel farther and less impeded than they might in other rock types.

The PA takes these considerations into account to evaluate ground water likelihood of release and targets. The presence of karst terrain in the vicinity of the site is used as an indicator of a high potential to release at sites where an actual release is not suspected to have occurred. Also, secondary drinking water target populations in karst areas receive higher weighted values than those in non-karst areas.

You can identify karst terrain by the predominant presence of the types of topographic features mentioned above -- irregular topography, abrupt ridges, sinkholes, caverns, abundant springs, disappearing streams, and a general lack of well-developed surface drainage systems. These features are typically evident on topographic maps and/or aerial photographs. Geologic literature about the area can also confirm the occurrence of karst terrain. If in doubt as to whether the area around a site can be considered karst terrain, consult your staff geologist. Local experts at USGS or State geologic agency offices, university geology departments, or well drillers can also be consulted. If you have reason to believe that the area around the site can be described as karst, but remain uncertain, assume that it is karst.

Scoring Likelihood of Release

After completing your evaluation of the Criteria List for releases to ground water, including depth to aquifer and karst considerations, you should have a hypothesis as to whether you do or do not suspect a release. The following pages explain how to assign a score to the Likelihood of Release factor category, depending on whether your hypothesis is "Suspected Release" or "No Suspected Release."

Factor: Suspected Release

Definition: A professional judgment conclusion based on site and pathway conditions indicating that a hazardous substance is likely to have been released to ground water.

Evaluation Strategy: In scoring a suspected release, you are stating a hypothesis that a hazardous substance is likely to have been released to ground water. You may hypothesize a suspected release on the basis of available analytical data indicating that a release may have occurred; however, analytical data are not usually available for PA sites. For PA purposes, your professional judgment is usually based on indications -- which is not the same as documented fact.

The Criteria List for releases to ground water (discussed on pages 53 to 56) helps guide the process of considering pertinent characteristics of the site and surrounding area that might lead you to suspect a release. You may hypothesize a suspected release on the basis of one or more characteristics of the site, its environs, sources, and type and quantity of wastes thought to be present.

It is not possible to provide comprehensive guidance on what does and does not "qualify" as a suspected release; you must rely on your professional judgment. Two examples of circumstances that might warrant a suspected release hypothesis are:

- ! Analytical data from a well 1,000 feet from the site indicate high concentrations of benzene and related organics. You may score a suspected release even though background concentrations are not available and you do not know whether the contaminants are specifically attributable to activities at the site.
- ! Liquid wastes and sludges have been stored outdoors in drums, some of which are rusted, perforated, and lying on the ground surface; areas of stained soil are visible; and the water table is known to be present at depths ranging from 20 to 50 feet within 2 miles of the site.

Scoring Instructions: Hypothesize and score a suspected release when available information leads you to conclude that there is a relatively high likelihood of a hazardous substance having migrated to ground water. Assign a score of 550 to factor #1 (Suspected Release) on the ground water pathway scoresheet (page 8 of the PA scoresheets); assign the score under Column A and use only Column A for the ground water pathway. Do not assign a score to factor #2 (No Suspected Release).

If you do not hypothesize a suspected release, score factor #2 (No Suspected Release).

GROUND WATER PATHWAY LIKELIHOOD OF RELEASE

Factor: No Suspected Release

Definition: A professional judgment conclusion based on site and pathway conditions indicating that a hazardous substance is not likely to have been released to ground water.

Evaluation Strategy: If you did not hypothesize a suspected release from your evaluation of the Criteria List, then your hypothesis must be that a release is not suspected. You must complete an evaluation of the Criteria List (left-hand column) before concluding that a release is not suspected.

Just as a hypothesis that a release is suspected is based on characteristics of the site, its environs, sources, and type and quantity of wastes thought to be present, so is the hypothesis that a release is not suspected. In this instance, however, available information leads you to conclude that there is a relatively low likelihood of a hazardous substance having been released to ground water.

Scoring Instructions: If you do not suspect a release to ground water, there are two possible scores to assign -- 340 or 500. To determine the appropriate score, consider the depth to the shallowest aquifer that supplies drinking water within the 4-mile target distance limit and the presence or absence of karst terrain. Both of these considerations appear on the Criteria List and their evaluation is discussed on pages 56 to 58.

If you do not suspect a release and:

- ! The site is located in an area of karst terrain, assign a score of 500 to factor #2 (No Suspected Release).
- ! The depth to aquifer is 70 feet or less, assign a score of 500 to factor #2.

If neither of these two specific conditions applies, assign a score of 340 to factor #2.

If No Suspected Release is scored, assign the score to factor #2 under Column B and use only Column B for the ground water pathway.

GROUND WATER PATHWAY TARGETS

3.3.2. Targets

Ground water pathway targets are drinking water supply wells within 4 miles of the site. For every PA site, you must develop a good understanding of the drinking water supply situation within the 4-mile target distance limit, and perform a comprehensive survey of drinking water supply systems and the number of people they serve. Very often, drinking water is supplied by some combination of domestic wells serving individual residences, community wells serving multiple residences, municipal wells serving entire towns or cities, and surface water supplies. For the ground water pathway, you are specifically concerned with private and public drinking water supply wells but, in the course of developing information about water supplies, you must also find out about surface water sources of drinking water (Section 3.4.2).

Your survey must be comprehensive enough to allow you to identify, on a topographic map, the location of each municipal drinking water well and surface water intake supplying drinking water within the target distance limit. Delineate on the map the specific geographic areas where drinking water is supplied by: municipal wells, municipal intakes, private and community wells, and private and community intakes. Note that, in some areas, private water companies supply drinking water to large numbers of people. These systems also fall within the meaning of a "municipal" system.

Multiple-Aquifer Systems

In researching the local water supply situation, you may find that drinking water is drawn from more than one aquifer. In many areas, multiple-aquifer systems provide drinking water from different aquifers at different depths. In such situations, the deeper aquifer(s) may or may not be at risk from a release from the site, depending on whether it is hydrogeologically isolated from overlying aquifers. Often, the extent to which one aquifer may be either isolated from or in hydraulic communication with another aquifer is not easily determined and even hydrogeologic experts may disagree. For these reasons, the PA evaluation of populations drinking ground water includes all persons served by all aquifers. Nonetheless, when researching drinking water populations, it is a good practice to develop as much information as possible concerning the populations associated with specific aquifers; such information may be useful to the SI if the site advances to that stage.

Municipal Drinking Water Supplies

The best place to begin a water supply survey is the local municipal and county water authorities. Bring your topographic map and ask the appropriate officials to locate municipal drinking water wells and intakes, including those that might be designated as "standby" or "backup," and to delineate the municipal distribution system. Very often, the entire system is interconnected -- by way of valves or connecting lines -- so that water drawn from any individual well or intake has the potential to reach any user of the system. This is referred to as a "blended system." In other cases, separate distribution systems function independently and do not have the capability for interconnection with other systems. Identify the specific systems that are blended, and the specific systems that are independent. You also need to know either the number of people served or the number of service connections in each blended and independent system, which wells and intakes supply each system, and the average annual production from each well and intake.

Drinking Water Supplies in Areas Not Served by a Municipal System

After identifying municipal wells, intakes, and distribution systems, investigate water supplies in areas outside of the municipal systems. People in these areas probably obtain water from private

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and community wells and/or intakes. Water authority officials may also be able to provide this information. If not, contact the local Health Department or Water Commission. Often, a permit from such an agency is required to drill or operate a private or community well, and the City or County Sanitarian (or similar official, often in the Health Department) is responsible for ensuring the potability of drinking water. Officials at these agencies are knowledgeable of local water use and can identify areas where domestic and community wells (or intakes) are used.

Identifying the Nearest Drinking Water Well

In addition to evaluating drinking water populations, the PA considers the proximity of the nearest drinking water well. If the areas around the site are supplied exclusively by municipal systems, the nearest drinking water well (and ground water target population) is easily determined through interviews with local water officials as discussed above. However, if areas around the site (closer than the nearest municipal well) do not have municipal water service, you'll want to have a good understanding of how drinking water is obtained and where the "nearest well" is located. If this still isn't clear after interviewing local officials, you may want to conduct a local survey. This might entail a "windshield" survey in which you drive through selected areas looking for residences with wellheads or pumphouses on the property and note their location on the topographic map. In some instances, a door-to-door survey may be appropriate, in which you briefly interview residents about their source of drinking water. Due to potential community relations concerns, be sure to consult your supervisors before undertaking such a survey. Windshield or door-to-door surveys need not be extensive, but limited to areas where you need to confirm locations of critical wells.

Evaluating Drinking Water Populations Served by Ground Water

Transcribe all of the well and distribution system locations onto the topographic map. In the PA evaluation of populations using ground water for drinking water, the "weight" given to secondary target populations is a function of how far their drinking water wells are from the site. On the topographic map, draw a series of concentric circles around the site with radii of $\frac{1}{4}$ mile, $\frac{1}{2}$ mile, 1 mile, 2 miles, 3 miles, and 4 miles. Evaluate drinking water populations according to the location of wells within these distance categories. Note that it is the location of the well that is important, not the location of the population served by that well.

The specific number of people served by a well or a municipal system is seldom known. Instead, water authorities are more likely to provide information on the number of service connections associated with the well or the distribution system. You then estimate the population by multiplying the number of service connections by the average number of persons per household for the county, using data from the U.S. Bureau of the Census. Likewise, assume each residence served by a private well represents the county average number of persons per household.

Populations Served by "Blended" Municipal Systems

A blended system is defined as "a drinking water supply system that can or does combine (e.g., via connecting valves) water from more than one well or surface water intake, or from a combination of wells and intakes." For PA purposes, it is the capability for interconnection that defines a blended system; for example, connecting lines between different parts of a distribution system may exist to allow uninterrupted service to the entire system in case of well failure or other emergency in one part of the system. Even if this capability has never actually been placed in service, the system is still considered a blended system.

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From interviews with local water officials, you should know whether any of the local systems are blended. If any systems are blended, you may need to apportion the drinking water population to individual wells (and intakes, if any).

Apportion populations when a blended system uses a combination of wells and intakes. For a blended system served solely by wells, apportionment is not necessary if any well serving the system is suspected to be a primary target (discussed on pages 65 to 70); in such a case, the entire drinking water population associated with the system is considered a primary target population. If all wells serving the system are secondary targets, apportionment is only necessary if the wells are located in more than one distance category, because secondary target populations are weighted according to the distance of their wells from the site. For example, a blended system served by four secondary target wells at distances ranging from 1.1 to 1.6 miles from the site would not require apportioning the drinking water population to individual wells because all four wells are located in the same distance category (1 to 2 miles). In contrast, a blended system served by four secondary target wells, one located 0.7 miles and the other three between 1.1 and 1.6 miles from the site, would require apportioning the population because the four wells are in two distance categories ($\frac{1}{2}$ to 1 mile, and 1 to 2 miles).

Local water officials can provide information on the number of people or connections served by each blended system, and the average annual production or production capacity of each well (and intake). If any signal well in the system can or does contribute more than 40 percent of the total output of the system, apportion populations to each well (and intake) on the basis of their relative contributions to the total. Do this on the basis of average annual production. If those data are not available, use production capacity instead. For example, consider a blended system drawing a total of 8.2 billion gallons of water annually from three wells serving a population of 120,000:

Well No.	Avg. Annual Production (gal)	% Total Production	% Total Population	Apportioned Population
1	2.4 billion	29.3%	29.3%	35,160
2	3.8 billion	46.3%	46.3%	55,560
3	2.0 billion	24.4%	24.4%	29,280
	8.2 billion	100.0%	100.0%	120,000

Use the same process to apportion populations for a blended system involving a combination of wells and surface water intakes; the population associated with intakes is scored in your evaluation of surface water pathway targets (Section 3.4.2).

If no well in a blended system can or does contribute more than 40 percent of the total system output, simply divide the total population equally among each well (and intake). For example:

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Well No.	Avg. Annual Production (gal)	% Total Production	% Total Population	Apportioned Population
1	3.1 billion	37.8%	33.3%	40,000
2	2.4 billion	29.3%	33.3%	40,000
3	2.7 billion	32.9%	33.3%	40,000
	8.2 billion	100.0%	100.0%	120,00

If neither average annual production nor production capacity data are available, apportion the population equally among each well (and intake) as a default measure.

When one or more wells in a blended system are backup or standby wells, apportioning populations becomes somewhat complicated. Backup wells may either be included in the apportionment or excluded:

Well No.	Avg. Annual Production (gal)	% Total Production	Population Apportionment	
			Including Backup	Excluding Backup
1	2.5 billion	30.5%	25.0%	33.3%
2	2.4 billion	29.3%	25.0%	33.3%
3	2.7 billion	32.9%	25.0%	33.3%
4 bkup	0.6 billion	7.3%	25.0%	—
	8.2 billion	100.0%	100.0%	100.0%

In determining whether to Include or exclude backup wells, select the approach that results in the highest population factor value. In general, this means selecting the approach that results in larger close-in populations, because secondary drinking water target populations served by wells closer to the site are weighted more heavily than those served by wells farther from the site. If backup wells are included, apportion populations to them just as you would to "regular" wells (on the basis of average annual production when such wells are actually in use, or production capacity).

If the blended system being evaluated also includes backup or standby surface water intakes, apportion populations to them only in connection with your evaluation of surface water pathway targets (Section 3.4.2).

Populations Served by Other Municipal Systems

For blended systems that do not require apportioning populations (e.g., all wells serving the system are secondary targets in the same distance category), simply multiply the number of service

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connections by the county average number of persons per household. Use the same approach for systems served by an individual well.

Populations Served by Private Domestic or Community Wells

Your water supply survey may identify areas within the target distance limit that are not served by municipal drinking water. Interviews with local water officials and windshield surveys should be used to confirm the areas where private domestic or community wells provide drinking water. To estimate populations, perform a "house count" from the USGS topographic map on which you have delineated the municipal water-supply systems; count only those residences located outside of municipal service areas. Multiply the number of counted residences by the county average number of persons per household.

House counts from outdated topographic maps should be verified by a windshield survey. However, due to the time required, the lower influence of more distant secondary target populations (see PA Table 2, page 9 of the PA scoresheets), and the wide population ranges used to assign factor values (PA Table 2), a windshield survey should generally not extend beyond 1 mile from the site. While conducting a windshield survey, be particularly alert for circumstances where a single community well might serve dozens of residences -- for example, a trailer park or new residential development.

Worker and Student Populations

Drinking water populations should include all people served by a given water supply system - - whether at home, in schools, or the work place. Water authorities commonly report the number of service connections, rather than the number of people drinking water from the system. Drinking water populations estimated by multiplying the number connections by the county average number of persons per residence generally do not accurately represent student and worker populations.

In some instances, it may be useful to pursue worker and student drinking water populations. If schools are present nearby and the local water authorities can confirm that they are served by ground water (as, for example, through the municipal system), student populations can be determined by telephone calls to school administrative offices. The drinking water supply of a major industrial installation (which may have its own well, or may be served by the municipal system) may be similarly investigated. However, due to the lower influence of more distant populations, time-consuming inquiries should generally be limited to distances less than 1 mile from the site. Unique exceptions to investigate beyond 1 mile are large institutions (e.g., university, large business complex) where thousands of students or workers drink ground water; also, any well that you suspect may be a primary target should be evaluated for drinking water population regardless of distance from the site.

Criteria List for Primary Target Wells

Identify which, if any, drinking water wells you consider to be primary targets and which you consider to be secondary. Identifying a primary target well represents a professional judgment, based on site, pathway, and target characteristics, that the well in question has a relatively high likelihood of exposure to a hazardous substance. Secondary targets have a relatively low likelihood of exposure.

The Criterial List can help guide the process of developing hypotheses about wells that might be considered primary targets. The right-hand column of the Criteria List identifies a number of target

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characteristics to consider. Carefully consider each element on the Criteria List for primary targets within the context of the site and its particular targets. Answers to every question on the list, however, are unlikely to be available for many sites. You need not spend excessive amounts of time to develop detailed information to respond to each question - it is possible to arrive at sound hypotheses about primary targets without knowing the answers to all questions on the list.

Also, keep in mind that there is an infinite variety of conditions that might lead you to identify a primary target, and no list of this type could identify them all. There are likely to be other considerations that may apply to a particular target, and you are encouraged to think along these lines. If such additional considerations enter into your conclusions, identify them at the bottom of the list.

Answer all questions on the list by checking the appropriate box marked "yes," "no," or "unknown." In evaluating each question, rely on all of the information you have obtained about the site and its targets through the course of your investigation - file searches, desktop data collection, site reconnaissance, interviews, etc.

Answers to many of the questions are likely to be fairly self evident. The difficult part lies in drawing the final conclusion, which amounts to a hypothesis as to whether a particular well is a primary target. This requires professional judgment and is a somewhat intuitive process that relies on your accumulated professional expertise and specific knowledge of site and target characteristics. Answer the bottom question "yes" or "no" regarding your conclusion whether a specific target may be affected by a release. Note that the Criteria List is not a tally sheet requiring a majority of "yes" or "no" responses to reach a conclusion. You may hypothesize that a particular well is a primary target on the basis of one or more target conditions or site characteristics that lead you to believe there is a relatively high likelihood of a hazardous substance having migrated to the target.

Primary Target Well Considerations

Each item on the Criteria list for primary target wells is briefly discussed below.

Is any drinking water well nearby?

If a release to ground water is suspected, proximity of wells to the site is a significant consideration; the closer the well, the higher the likelihood that it may be exposed to hazardous substances. Just what qualifies as "nearby" depends on circumstances specific to the site and its environs. Generally, any well with \leq mile is considered "nearby" and likely to be affected by a release of hazardous substances to ground water. Wells at greater distances up to $\frac{1}{4}$ mile (or more) might also be considered "nearby," depending on you know or suspect about the depth to aquifer, depth of the screened interval, permeability of the subsurface, presence of karst conditions, mobility of hazardous substances suspected to be associated with the site, and other circumstances.

Has any nearby drinking water well be closed?

You may encounter where a drinking water well on or near the site has been closed or abandoned. There are any number of reasons why this might have occurred, and it may not be possible to find out why. If you have reason to suspect that a well was abandoned due to water quality problems or concerns about the site, it is appropriate to evaluate that well as if it were still functioning and consider it a primary target. If you don't know why the well was

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abandoned, it is best to assume the closure was associated with concerns about contamination and evaluate it as a primary target. On the other hand, if the closure resulted from a problem that could not possibly be related to the site (for example, a domestic well was abandoned because municipal water service became available, or because the residence burned down and the owners moved away), it would not be appropriate to consider that well a primary target.

Has any nearby drinking water user reported foul-tasting or foul-smelling water?

If you have learned about water quality problems from the local Health Department or any other source during your investigation, it may be appropriate to suspect that these problems are associated with the site and to evaluate the affected wells as primary targets. Reference any accounts of suspicious, foul-tasting, foul-smelling, or off-colored drinking water.

Does any nearby well have a large drawdown or high production rate?

High-production wells may create a "cone of depression" that draws down the water table in the vicinity of the well as large quantities of water are "sucked" to the well. The result is an influence on local ground water flow gradients that could speed the movement of hazardous substances through the aquifer and directly to the well, thus increasing the likelihood of exposure.

Is any drinking water well located between the site and other wells that are suspected to be exposed to a hazardous substance?

If any well has been identified as a suspected primary target, and there are other wells located between it and the site, it is appropriate to assume that those other wells are also likely to be affected and to evaluate them as primary targets. Similarly, other wells that are near a primary target well, but not necessarily between it and the site, might also be evaluated as primary targets.

Does analytical or circumstantial evidence suggest contamination at a drinking water well?

The distinction between "ground water" and "drinking water" is that, while all drinking water drawn from wells is ground water, all ground water is not necessarily drinking water. Likewise, not all wells are necessarily drinking water wells. If there is reason to suspect contamination of a well which supplies irrigation water or contamination of a monitoring well, it would be appropriate to consider nearby drinking water wells as primary targets.

Does any drinking water well warrant sampling?

Perhaps the most straightforward test to identify primary targets is to ask yourself the question "Given what I know and suspect about this site, would I recommend that this well be sampled (during an SI, for example) with the expectation of detecting hazardous substances there?" If the answer to this question is "yes," you have come to a professional judgment identifying a primary target.

After answering these questions, and adding any other considerations to the list, indicate your professional judgment as to the occurrence of primary targets by checking the appropriate box next to the "Primary Target(s) Identified?" question.

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To score any well as a primary target, you must first score a suspected release; a release is a precondition to a conclusion that a particular well has a relatively high likelihood of exposure to a hazardous substance. If your evaluation of the Criteria List leads you to believe that one or more wells should be considered primary targets, yet your earlier evaluation of likelihood of release led you to the No Suspected Release hypothesis, you should revisit the Criteria List for suspected releases and reconsider your judgment regarding the likelihood of release.

If your evaluation of the Criteria List leads you to conclude that some wells should be considered primary targets, summarize your rationale and identify the wells.

GROUND WATER PATHWAY TARGETS

Factor: Primary Target Population

Definition: The human Population served by drinking water drawn from primary target wells.

Evaluation Strategy: Identifying a primary target well represents a professional judgment based on site, pathway, and target characteristics indicating a relatively high likelihood that a hazardous substance has migrated to the well. A primary target may be hypothesized on the basis of available analytical data indicating that the well may be exposed to hazardous substances; however, analytical data are not usually available for PA sites. For PA purposes, your professional judgment is usually based on indications - - which is not the same as documented fact. You may hypothesize a primary target well on the basis of one or more characteristics of the site and its environs, sources, and types and quantity of wastes thought to be present, coupled with the proximity and physical characteristics of the well itself.

Use the Criteria List for primary targets to help guide the process of considering pertinent characteristics that might lead you to identify a primary target well. The application of the Criteria List is discussed on pages 65 to 68.

It is not possible to provide comprehensive guidance on what does and does not “qualify” as a primary target; you must rely on your professional judgment. A few example scenarios are give below:

- ! Analytical data from a drinking water well 1,000 feet from the site indicate high concentrations of benzene and related organics. A suspected release has been hypothesized, even though background concentrations are not available and you cannot attribute the contaminants specifically to activities at the site. In this case, evaluate the well as a primary target, since the condition of the well contributed to the judgment that a release is suspected.
- ! Liquid wastes and sludges have been stored outdoors in drums, some of which are rusted, perforated, and lying on the ground surface; areas of stained soil are visible; the water table in the area is 20 to 50 feet deep; and a suspected release has been scored on these considerations. No analytical data are available, but a drinking water well (depth unknown) is 1,000 feet from the site. In this case, the well may be evaluated as a primary target on the basis of proximity to a suspected release.

(continued)

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- ! Conditions are as described above, except the well is known to be screened at a depth of 300 to 350 feet. In this case, even though a suspected release is scored, the well might not be evaluated as a primary target, due to its depth.
- ! Conditions are as described above, except it is known that drinking water within 4 miles is obtained only from aquifers below 300 feet and no release is suspected to impact that aquifer depth. In this case, the well would not be evaluated as a primary target.

Remember that, in order to evaluate any well as a primary target, a suspected release to ground water must first be scored. In such cases, you may identify both primary and secondary targets. If a release is not suspected, there can be no primary targets.

Scoring Instructions: Evaluate a drinking water well as a primary target when available information leads you to hypothesize that there is a relatively high likelihood that a hazardous substance has migrated to the well.

Determine the population served by each primary target well as discussed on pages 61 to 65. Briefly:

- ! For each private domestic well, count the number of persons in households or assign a population equal to the average number of persons per household in the county using U.S. Bureau of the Census data (round up to the next integer for each household).
- ! For a well serving more than one residence (community or municipal wells), determine the number of people served by the well and assign that population. If the specific number of people served is not available from the operating authority, determine the number of service connections associated with the well. Multiply this number by the county average number of persons per household (round up to the next integer before multiplying) and assign the resulting population to the well. Apportion populations if blended systems are served by multiple wells or a combination of wells and intakes, and show your calculations on page 6 of the PA scoresheets.
- ! For a well serving a distinct non-residential population (a business, industrial park, school, or university, for example), determine the population served by interviewing the well owner/operator or facility administrator and assign this population to the well.

Sum the populations served by each primary target well, regardless of distance from the site. Enter the total primary target population on the blank for factor #3 (Primary Target Population) on the ground water pathway scoresheet (page 8 of the PA scoresheet). Multiply this total by 10 and enter resulting factor score under Column A.

If your evaluation of the Criteria List led you to conclude that there are no primary target wells, assign a zero score to factor #3.

GROUND WATER PATHWAY TARGETS

Factor: Secondary Target Population

Definition: The human population served by drinking water drawn from secondary target wells.

Evaluation Strategy: Just as the identification of primary target wells represents a professional judgment based on site, pathway, and target characteristics, so is the identification of secondary target wells. In this instance, however, available information leads you to conclude that the wells in question have a relatively low likelihood of exposure to a hazardous substance. You base this determination on one or more characteristics of the site and its environs, sources, and types and quantity of wastes thought to be present, coupled with the proximity and physical characteristics of the wells.

Note that, if a release is suspected, some targets may be evaluated as primary targets and some as secondary targets. However, if no release is suspected, all targets are evaluated as secondary targets.

After completing your ground water targets survey and applying the Criteria List, you will have a set of hypotheses identifying the wells that you believe are secondary targets. Application of the Criteria List is discussed on pages 65 to 68.

Assign populations to each secondary target well and develop separate secondary target population totals for each distance category around the site: less than $\frac{1}{4}$ mile, $\frac{1}{4}$ to $\frac{1}{2}$ mile, $\frac{1}{2}$ to 1 mile, 1 to 2 miles, 2 to 3 miles, and 3 to 4 miles. Secondary target populations are determined and summed for each distance category because different weights are applied to populations according to distance from the site in order to account for the dispersion of substances that may enter ground water. The weights are built into PA Table 2 and become smaller with distance from the site to reflect greater dispersion with distance.

When you have completed your target survey and transcribed the locations of municipal and community wells onto the topographic map, and also delineated the areas served by municipal, community, and domestic wells, determining secondary target populations is relatively straightforward. Completing a targets survey, evaluating target populations associated with each well, and apportioning populations in blended systems are discussed pages 61 to 65.

(continued)

GROUND WATER PATHWAY TARGETS

Scoring Instructions: Evaluate a drinking water well as secondary target when available information leads you to conclude that there is a relatively low likelihood of a hazardous substance having migrated to the well.

Draw the six distance categories on the topographic map in order to clearly delineate and identify the wells whose associated populations will be summed for each category, and to see which categories include areas relying on domestic wells. Determine the population served by each secondary target well as discussed on pages 61 to 65. Briefly:

- ! For each private domestic well, assign a population equal to the average number of persons per household for the county using data from the U.S. Bureau of the Census (for secondary target populations, do not round the average up to the next integer).
- ! For a well serving more than one residence (community or municipal well), determine the number of people served by the well and assign that population to the well. If the specific number of people served is not available from the authority operating the well, determine the number of service connections associated with the well. Multiply this number by the county average number of persons per household (do not round the average up to the next integer) and assign the resulting population to the well. If necessary, apportion populations.
- ! For wells serving a distinct non-residential population (a business, industrial park, or university, for example), determine the population served by interviewing the well owner/operator or facility administrator and assign that population to the well.

For each distance category, sum the population served by secondary target wells. Score a non-karst aquifer using PA Table 2a (page 9 of the PA scoresheets); score a karst aquifer using PA Table 2b. For each distance category, using the appropriate table:

- 1) Enter the secondary target population for the distance category in the "Population" column.
- 2) Working horizontally across the table, circle the value in the same row that represents the range that the distance-category population falls into.
- 3) Record the circled value in the same row of the "Population Value" column.

Sum the population values in the far-right column. Record this total at the bottom of the column and in one of the blanks for a factor #4 (Secondary Target Population) on the ground water pathway scoresheet. Use the blank under Column A if you scored a suspected release; use the blank under Column B if you scored "No Suspected Release." Mark your response to the question "Are any wells part of a blended system?" If you have apportioned populations, show your calculations on page 6 of the PA scoresheets.

GROUND WATER PATHWAY TARGETS

Factor: Nearest Well

Definition: The drinking water well closest to any source at the site.

Evaluation Strategy: In addition to evaluating both primary and secondary target populations, the PA also evaluates the distance to the nearest drinking water well. This distance is an indicator of the magnitude of the threat the site may pose to ground water users. All other considerations being equal, the closer a drinking water well is to the site, the higher the threat that the well might be exposed to a hazardous substance. If you have identified any primary target well you have, in effect, hypothesized that the threat or likelihood of exposure is relatively high. For this reason, whenever a primary target well is present, assign a score of 50 to the Nearest Well factor, regardless of distance.

If there are no primary target wells, identify the nearest secondary target well and assign a distance-weighted factor score using PA Table 2. Estimate the straight-line distance between that well and the nearest source at the site. After completing your ground water target survey and transcribing this information onto a topographic map, use a ruler or pair of dividers to identify the secondary target well nearest to any source on the site and convert that map distance to feet using the map scale. If the nearest well is so close that map measurement is not practical, estimate the distance through visual observation during the site reconnaissance. Annotate the topographic map to identify the well. Record the distance in the "Pathway Characteristics" box on the ground water pathway scoresheet. Record an absolute number (e.g., "800 feet"), not a range (e.g., "800 - 900 feet" or "less than 900 feet"), accurate within a margin of ± 100 feet.

Scoring Instructions: If you have identified any primary target well within the target distance limit, assign a score of 50 to factor #5 (Nearest Well); assign the score under Column A.

Otherwise, identify the nearest secondary target well on the topographic map. Enter the distance to this well in the "Pathway Characteristics" box on the ground water pathway scoresheet. Using either PA Table 2a or 2b (page 9 of the PA scoresheets) for non-karst or karst aquifers, as appropriate, select the distance category in which the nearest secondary target well is located (left-hand column). Circle the value on the same line in the column labeled "Nearest Well." Record this circled value in one of the blanks for factor #5 (Nearest Well) on the ground water pathway scoresheet. Use the blank under Column A if you scored "Suspected Release" for the Likelihood of Release factor category; use the blank under Column B if you scored "No Suspected Release."

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Factor: Wellhead Protection Area

Definition: A State-designated area restricting certain land uses and industrial practices around drinking water wells that might be susceptible to adverse impacts.

Evaluation Strategy: Wellhead protection areas (WHPAs) are designated by State authorities under Section 1428 of the Federal Safe Drinking Water Act. WHPAs protect principal drinking water supplies from contamination that might otherwise result from unrestricted waste disposal or other industrial practices. The importance of protecting such water supplies is reflected in the PA by the Wellhead Protection Area factor. State environmental agencies and local water authorities can provide information about the locations of WHPAs.

Scoring Instructions: If any source associated with the site lies within or above a designated WHPA, or if you have identified any primary target well within a WHPA, assign a score of 20 to factor #6 (Wellhead Protection Area). If neither of these conditions apply, but any part of a designated WHPA is within 4 miles of the site, assign 5. If no portion of a designated WHPA lies within 4 miles of the site, assign a zero score. Use the blank under Column A if you scored a "Suspected Release" for the Likelihood of Release factor category; use the blank under Column B if you scored "No Suspected Release."

Factor: Resources

Definition: Use of ground water for purposes other than drinking water.

Evaluation Strategy: In addition to providing drinking water, ground water is often used for other purposes that could affect human health:

- ! Irrigation (5 acre minimum) of commercial food crops or commercial forage crops.
- ! Watering of commercial livestock.
- ! Ingredient in commercial food preparation (e.g., canning plant).
- ! Supply for commercial aquaculture (e.g., hydroponic greenhouse, catfish farm).
- ! Supply (other than drinking water supply) for a major or designated water recreation area (e.g., municipal swimming pool).
- ! Potential usability as drinking water supply, though the resource is not currently used for drinking water.

The PA accounts for such use through the resources factor, which is assigned a value of 5 if any of the above resource uses are present within 4 miles; a zero value is assigned if there is no resource use.

Since ground water often has some beneficial use, the resources factor can generally be assigned 5 points as a default measure. This approach is conservative from the scoring perspective (as the maximum value is assigned), has little impact on the pathway and site score, and can potentially save you many hours of research trying to determine crop acreage, "commercial" uses, "major or designated" areas, and "usability."

Scoring Instructions: If, within 4 miles of the site, ground water is used for any of the purposes itemized above, assign a score of 5 to one of the blanks for factor #7 (Resources) on the ground water pathway scoresheet; otherwise, assign a zero value. Alternatively, simply assign the 5 point value as a default measure. Use the blank under Column A if you scored a "Suspected Release" for the Likelihood of Release factor category; use the blank under Column B if you scored "No Suspected Release."

Total Targets: Calculate the Targets factor category score by summing the scores assigned to factors #3 through 7. Factor scores should appear in only one of the two columns (A or B) depending on whether you scored a suspected release.

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3.3.3 Waste Characteristics

The evaluation of the Waste Characteristics factor category is discussed in Section 3.2.2.

If you have identified any primary target well, assign either the waste characteristics score (WC) that you calculated using PA Table 1 (Section 3.2.2, and page 4 of the PA scoresheets) or a score of 32 -- whichever is greater -- to factor #8a. Assign this score under Column A. Do not evaluate factor #8b.

If you have not identified any primary target well, assign the waste characteristics score (WC) that you calculated using PA Table 1 (Section 3.2.2, and page 4 of the PA scoresheets) to factor #8b. Assign the score under Column A if you scored "Suspected Release" for Likelihood of Release; under Column B if you scored "No Suspected Release." Do not evaluate factor #8a.

3.3.4 Calculating the Ground Water Pathway Score

The ground water pathway scoresheet is organized by the three factor categories: Likelihood of Release (LR), Targets (T), and Waste Characteristics (WC). Enter the score for either Suspected Release (factor #1) or No Suspected Release (factor #2) into the box labeled "LR." Sum the Target scores (factors #3 through 7) down the appropriate column and record the sum in the box labeled "T." Enter the Waste Characteristics score (factor #8a or 8b) into the box labeled "WC." All scores should appear in either Column A or Column B, depending on your evaluation of Likelihood of Release.

Multiply LR x T x WC; divide the product by 82,500; round to the nearest integer; and record the result, subject to a maximum of 100, as the ground water pathway score at the bottom of the page. If your calculated score exceeds 100, assign 100 as the pathway score.

3.4 SURFACE WATER PATHWAY

The PA evaluation of the surface water pathway requires you to consider and assign scores to factors in three factor categories: Likelihood of Release, Targets, and Waste Characteristics.

Evaluating likelihood of release requires you to hypothesize whether hazardous substances are likely to have migrated to surface water. When a release is not suspected, special considerations that enter into your scoring decision include the distance to surface water and the flood potential at the site.

Definition: Surface Water -- A naturally-occurring, perennial water body; also, some artificially-made and/or intermittently-flowing water bodies.

Surface waters include streams and rivers, lakes, coastal tidal waters, and oceans. The glossary provides detailed definitions for each type. Note that certain ditches and intermittently-flowing waters are included in the "streams and rivers" water body type. Specifically, ditches qualify as surface water if they perennially flow into other surface water. In areas where mean annual precipitation is less than 20 inches, intermittently-flowing waters and contiguous intermittently-flowing streams and ditches also qualify as surface water.

If there is no surface water within an overland flow distance of 2 miles from the site, do not evaluate the surface water pathway for that site. Do, however, identify the nearest surface water body and its distance from the site, and record this information on the PA scoresheet as your reason for not evaluating the pathway.

Release of a hazardous substance to surface water could threaten drinking water supplies, human food chain organisms, and sensitive environments. The targets portion of the surface water pathway is thus divided into these three separate threat evaluations. You must identify and evaluate intakes supplying drinking water, fisheries, and surface water sensitive environments within a 15-mile target distance limit.

The evaluation and score for the waste characteristics factor category (W.C., Section 3.2.2) applies directly to the surface water pathway, as to all other pathways, except if primary targets are identified for any of the three threats (Section 3.4.3).

SURFACE WATER PATHWAY LIKELIHOOD OF RELEASE

3.4.1 Likelihood of Release

Evaluating the Likelihood of Release factor category requires a professional judgment, based on site and pathway conditions, as to whether a hazardous substance is likely to have been released to surface water. Likelihood of Release is scored on the basis of one of two scenarios, "Suspected Release" or "No Suspected Release," either of which require you to make this professional judgment. Your judgment takes the form of a hypothesis that a release has or has not occurred. The formulation of your hypothesis is guided by the "Criteria List" (page 11 of the PA scoresheets).

Criteria List for Suspected Release to the Surface Water Pathway

The Criteria List helps guide the process of developing hypotheses about two very important aspects of the site: whether a hazardous substance is likely to have been released to surface water; and whether any targets (intakes supplying drinking water, fisheries, sensitive environments) are likely to be exposed to a hazardous substance as a result of a release. The Criteria List suggests a number of characteristics of the site and its environs to consider in reaching conclusions on these points. Answer the questions in the left-hand column of the Criteria List, which deal with a suspected release; the right-hand column, dealing with primary targets, is evaluated in connection with the Targets factor category (Section 3.4.2) if you conclude that a release to surface water is likely to have occurred.

Carefully consider each element on the Criteria List within the context of the site and its environs. Answers to every question on the list, however, are unlikely to be available for many sites. You need not spend excessive amounts of time trying to develop detailed information to respond to each question -- it is possible to arrive at sound hypotheses about suspected releases and their potential effects on targets without knowing the answers to all questions on the list.

Also, keep in mind that because there is an infinite variety of site-specific circumstances, no list of this type could identify every characteristic that might apply to any specific site. The list, therefore, is by no means complete and the criteria making up the list are not prioritized in any way. Instead, these questions are meant to get you thinking about the types of site-specific conditions that need to be considered when formulating hypotheses about releases and the condition of targets. There are likely to be other site-specific criteria that apply to a particular site, and you are encouraged to think along these lines. If such additional considerations enter into your conclusions, identify them at the bottom of the list.

Answer the questions on the list by checking the appropriate box marked "yes," "no," or "unknown." In evaluating each question, rely on the total body of information you have obtained about the site and its environs through the course of your investigation -- file searches, desktop data collection, site reconnaissance, interviews, etc.

Answers to many of the individual questions are likely to be fairly self evident. The difficult part lies in drawing the final conclusion, which amounts to a hypothesis as to whether you suspect a release. This requires professional judgment and is a somewhat intuitive process that relies upon your accumulated professional expertise and specific knowledge of site and target characteristics. Note that the Criteria List is not a tally sheet requiring a majority of "yes" or "no" responses to reach a conclusion. You may hypothesize a suspected release on the basis of one or more characteristics that lead you to believe there is a relatively high likelihood that a hazardous substances has been released to surface water.

Suspected Release Considerations

Each item on the Criteria List for suspected releases to surface water is briefly discussed below.

Is surface water nearby?

Proximity is directly related to the ease with which hazardous substances can migrate to surface water. In general, the nearer the site is to surface water, the higher the likelihood of a release. Just what constitutes "nearby" depends on site-specific conditions. If the surrounding terrain is flat, precipitation is low, and soils are sandy (high infiltration), a couple of hundred feet might be considered "nearby"; if a drainage channel runs past the site and annual precipitation or occasional rainfall events are high, $\frac{3}{4}$ mile might still be considered "nearby." Note that sites where the overland flow distance to the nearest surface water is more than 2 miles are not evaluated for the surface water pathway.

Is waste quantity particularly large?

Depending on the type of waste, its physical state, and its location, "large" is a relative term with respect to the potential for a release to surface water. In this context, a relatively small quantity of liquid wastes spilled on the ground surface probably has more importance than a relatively large quantity of solid wastes deposited in a landfill. In general, however, any amount is considered "large" if it produces a waste characteristics factor category score (WC) of 32 or more.

Is the drainage area large?

"Drainage area" refers to the area of the site itself plus the area upgradient of the site that produces runoff flowing over the site. Larger drainage areas generally produce more runoff that could potentially carry hazardous substances overland to surface water. Note that, in urban areas, curbed streets and storm sewers may effectively limit the drainage area to the area of the site itself.

Is rainfall heavy?

If the site and surrounding areas are flat, the combination of heavy rainfall and low infiltration rate may cause rainwater to pool on the site. Otherwise, these characteristics will contribute to generating runoff that may carry hazardous substances overland to surface water.

Total annual rainfall exceeding 40 inches, or 2-year, 24-hour rainfall exceeding 2 inches might be considered "heavy." You can obtain this information from the "Climatic Atlas of the United States," published by the U.S. Department of Commerce, or from local weather stations.

Is the infiltration rate low?

Infiltration rates range from very high in gravelly and sandy soils to very low in fine silt and clayey soils. You can find out about soil types in the area of the site from the County Extension Office of the USDA Soil Conservation Service, or from soil survey maps published by the SCS for most counties in the nation. Paved sites, of course, prevent infiltration and generate runoff.

SURFACE WATER PATHWAY LIKELIHOOD OF RELEASE

Are sources poorly contained or prone to runoff or flooding?

For many types of sources, proper containment that would prevent hazardous substances from migrating to surface water requires engineered structures such as dikes, berms, run-on and runoff control systems, and spill collection and removal systems. Such controls would have to be designed to meet the specific requirements of containing the contents of the source against migration to surface water, and would have to be regularly inspected and properly maintained. This level of containment for all sources is not often found at CERCLIS hazardous waste sites.

In general, sources that may be prone to releasing hazardous substances via runoff are those over which drainage might flow: sources resulting from leaks, spills, or intentional deposition or disposal of hazardous wastes on the ground surface. Sources not prone to runoff include underground tanks, above-ground tanks, and containers stored in a building.

Any source on a site prone to flooding has a likelihood of releasing hazardous substances to surface water that is directly related to flood frequency, which is discussed later in this section.

Is a runoff route well defined?

The runoff route is the downgradient path that runoff follows from the site to surface water. A runoff route may be engineered (e.g., storm drains, drainage ditch) or natural. In general, in the case of a natural overland route, the closer the site is to surface water and the steeper the terrain is, the easier it will be to identify the route. A well defined runoff route will more likely contribute to migration to surface water than a poorly defined one.

Is vegetation stressed along the probable runoff route?

Once you have identified the runoff route, examine the condition of vegetation on and adjacent to it. Vegetation that is dead, dying, stunted, discolored, or otherwise distressed may indicate that hazardous substances have been carried overland by runoff.

Are sediments or water unnaturally discolored?

An unnatural color to ponded water or sediments along the runoff route, or to sediments or water in the water body itself, may indicate that hazardous substances have migrated from the site.

Is wildlife unnaturally absent?

An unnatural absence of wildlife (terrestrial or aquatic), a decline in populations, a fishkill, or similar adverse environmental effects in or around a water body may also indicate that hazardous substances have migrated to surface water. Local fish and game officials may have such information.

Has deposition of waste into surface water been observed?

Visual (or alleged) evidence of direct deposition of what you suspect may be hazardous waste could include an outfall pipe from the site direct to surface water or to a ditch (or gully, swale, etc.) leading to surface water, presence of a plume in surface water, or presence of a drum in a river bank or creek bed.

SURFACE WATER PATHWAY LIKELIHOOD OF RELEASE

Is ground water discharge to surface water likely?

If there is no apparent overland runoff route to surface water (and even in cases where there is), consider the potential for hazardous substances to reach surface water by migrating through ground water. This could be a concern in karst areas (see Section 3.3.1), in cases where surface water is nearby and a steep hydraulic gradient is known to exist between the site and surface water, or when available evidence strongly suggests that ground water is contaminated (not merely suspected to be contaminated). Note that in order to score a suspected release to surface water via ground water, you must also score a suspected release to ground water.

Does analytical or circumstantial evidence suggest surface water contamination?

"Circumstantial" implies a level of certainty well below that of "proven fact," and this is sufficient for PA purposes. In this context, any condition that you find suspicious, and that indicates a possible contamination problem, can be considered circumstantial evidence. A few examples are:

- ! Analytical data provide indications of hazardous substances in surface water, regardless of whether you can attribute those substances specifically to the site.
- ! The surface water body has been sampled by State, local, or site officials, whether or not you know the results.
- ! Fishing or recreational use of the surface water body has been curtailed for health or other reasons that may be associated with the site.

After answering these questions, and adding other considerations to the list, indicate your professional judgment as to the likelihood of a release of hazardous substances by checking "yes" or "no" next to the "Release Suspected?" question. Remember that this is a judgment call; you don't need a majority of "yes" responses -- in some cases, a single "yes" may be sufficient to suspect a release. Summarize the rationale for your hypothesis.

Special Considerations When a Release is Not Suspected

If your evaluation of the Criteria List leads you to conclude that a release to surface water is suspected, two specific considerations are important to assign the PA score for Likelihood of Release: distance to surface water and flood frequency. Both are included in the Criteria List, but are discussed in more detail here due to their importance when a release is not suspected.

Distance to Surface Water

Definition: Distance to Surface Water -- The shortest distance that runoff would follow from a source to surface water.

Distance to surface water can be used as an indicator of the likelihood of release of hazardous substances to surface water. Given two sites with similar characteristics, except that Site A is

SURFACE WATER PATHWAY LIKELIHOOD OF RELEASE

located closer to surface water than Site B, you might expect Site A to have a higher likelihood of releasing hazardous substances to surface water.

To evaluate distance to surface water, identify the shortest runoff route from the site to the probable point of entry (PPE) to a surface water body. Note that this is a downgradient distance and is unlikely to be a straight line.

Definition: Probable Point of Entry -- The point at which runoff from the site most likely enters surface water.

As part of your site reconnaissance (Section 2.5), identify the drainage patterns on and flowing from the site. To the extent that it is easily accomplished, you may want to physically follow the runoff route to the PPE. This may be possible if surface water is near the site, the runoff route is well defined, and following it doesn't require trespassing on private property. If these conditions do not apply, follow the runoff route to a landmark identifiable on a topographic map. Using the elevation contours, you can then map the runoff route to the PPE. Do this by drawing the shortest probable route, between the landmark and the PPE, that crosses each intervening contour line at a right angle.

If there is more than one runoff route to one or more surface water bodies, identify the shortest distance among the various possibilities.

Estimate distances using a map wheel or calibrated string; if the distance is short and measurement from a map is not practical, estimate the distance by visual observation during the site reconnaissance. For tidally-influenced water bodies, estimate the distance to the mean high water level; for other water bodies, estimate to the mean water level. Record the distance in the "Pathway Characteristics" box on the surface water pathway scoresheet (page 12 of the PA scoresheets). The distance you record must be an absolute number (e.g., "1,800 feet"), not a range (e.g., "1,000 - 2,000 feet" or "less than ½ mile"), and should be accurate within a margin of ± 100 feet.

If it is too difficult to reasonably approximate a runoff route, as a default measure you may use the shortest straight-line distance from the site to the surface water body.

In urban areas, the runoff route may not follow the apparent gradient because curbed roads direct drainage to storm sewers that carry it to an outfall to surface water (perhaps passing through a wastewater treatment plant along the way). In these cases, you could determine the runoff route by obtaining the storm sewer layout plans from the local highway or public works department, but this approach is not recommended because it is time consuming. Instead, ask the highway or public works department to locate storm sewer outfalls on your topographic map, and measure the straight-line distance from the site to the nearest outfall.

Sketch the runoff route(s), as part of the larger surface water migration route sketch, on page 10 of the PA scoresheets.

SURFACE WATER PATHWAY LIKELIHOOD OF RELEASE

Flood Frequency

The location of the site with respect to surface water floodplains is a second indicator of likelihood of release and is also directly related to distance from surface water. Floodplains are delineated on the basis of statistical analysis of long-term records of stream flow. The Federal Emergency Management Agency (FEMA) publishes "Flood Insurance Rate Maps." Local planning departments or zoning commissions generally have these maps, or you can obtain them directly from FEMA. Homeowner insurance companies may also be able to provide flood frequency maps for areas where FEMA maps may not be available.

FEMA Flood Insurance Rate Maps delineate 100-year and 500-year floodplains. Maps produced by local planning commissions and similar authorities may be more detailed and also delineate the annual and 10-year floodplains. Areas located in the annual floodplain can typically be expected to flood about once every year. The 100-year floodplain includes the annual floodplain, 10-year floodplain, 50-year floodplain, and so forth -- areas that can be expected to suffer flooding at least once over a 100-year period. Similarly, the 500-year floodplain includes the annual floodplain, the 100-year floodplain, and other areas subject to flooding at least once over a 500-year period. Areas beyond the 500-year floodplain are not expected to flood except under the most extreme of circumstances -- circumstances that are expected to occur less frequently than once in a 500-year period.

Locate the site on a floodplain map. Record the flood frequency in the "Pathway Characteristics" box on the surface water scoresheet; this should be the most frequent flood event appropriate to the site. For example, while it is true that a site located in the 10-year floodplain could also be said to be in the 100-year and 500-year floodplains, record the flood frequency for this site as 10 years.

Scoring Likelihood of Release

After completing your evaluation of the Criteria List for releases to surface water, including distance to surface water and flood frequency, you should have a hypothesis as to whether you do or do not suspect a release. The following pages explain how to assign a score to the Likelihood of Release factor category, depending on whether your hypothesis is "Suspected Release" or "No Suspected Release."

SURFACE WATER PATHWAY LIKELIHOOD OF RELEASE

Factor: Suspected Release

Definition: A professional judgment conclusion based on site and pathway conditions indicating that a hazardous substance is likely to have been released to surface water.

Evaluation Strategy: In scoring a suspected release, you are stating a hypothesis that a hazardous substance is likely to have been released to surface water. You may hypothesize a suspected release on the basis of available analytical data indicating that a release may have occurred; however, analytical data are not usually available for PA sites. For PA purposes, your professional judgment is usually based on indications -- which is not the same as documented fact.

The Criteria List for releases to surface water (discussed on pages 78 to 81) helps guide the process of considering pertinent characteristics of the site and surrounding area that might lead you to suspect a release. You may hypothesize a suspected release on the basis of one or more characteristics of the site, its environs, sources, and type and quantity of wastes thought to be present.

It is not possible to provide comprehensive guidance on what does and does not "qualify" as a suspected release. You must rely on your professional judgment. Two examples of circumstances that might warrant a suspected release hypothesis are:

- ! Several surface impoundments containing liquid and sludge are present onsite, some or all of which show evidence of having overflowed. The ground surface is stained and vegetation is absent in the overflow area; vegetation elsewhere on the site appears stressed. Drainage patterns are difficult to discern because the site itself is basically flat, but there is a boggy area adjacent to the site and about 600 feet from the nearest impoundment. A small creek originates from the bog.
- ! Sources are as described above, but much of the site has a discernible slope that appears to define a runoff route to a ditch bordering the site. The ditch is dry for 1,200 feet downgradient of the site, where perennial flow appears to begin; the ditch then flows an additional 900 feet before emptying to a creek.

Scoring Instructions: Hypothesize and score a suspected release when available information leads you to conclude that there is a relatively high likelihood of a hazardous substance having migrated to surface water. Assign a score of 550 to factor #1 (Suspected Release) on the surface water pathway scoresheet (page 12 of the PA scoresheets); assign the score under Column A and use only Column A for the surface water pathway. Do not assign a score to factor #2 (No Suspected Release).

If you do not hypothesize a suspected release, score factor #2 (No Suspected Release).

SURFACE WATER PATHWAY LIKELIHOOD OF RELEASE

Factor: No Suspected Release

Definition: A professional judgment conclusion based on site and pathway conditions indicating that a hazardous substance is not likely to have been released to surface water.

Evaluation Strategy: If you did not hypothesize a suspected release from your evaluation of the Criteria List, then your hypothesis must be that a release is not suspected. You must complete an evaluation of the Criteria List (left-hand column) before concluding that a release is not suspected.

Just as a hypothesis that a release is suspected is based on characteristics of the site, its environs, sources, and type and quantity of wastes thought to be present, so is the hypothesis that a release is not suspected. In this instance, however, available information leads you to conclude that there is a relatively low likelihood of a hazardous substance having been released to surface water.

Scoring Instructions: If you do not suspect a release to surface water, evaluate likelihood of release on the basis of two conditions -- distance to surface water and flood frequency. Both of these considerations appear on the Criteria List and their evaluation is discussed on pages 81 to 83.

If distance to surface water is 2,500 feet or less, assign a score of 500.

If distance to surface water is greater than 2,500 feet, assign a score based on flood frequency:

Site in annual or 10-year floodplain	500
Site in 100-year floodplain	400
Site in 500-year floodplain	300
Site outside 500-year floodplain	100

If any source or any part of the site lies within the annual floodplain, or if the site is known to have flooded during the period when hazardous wastes were present, you should review your conclusion of No Suspected Release and consider scoring the site on the basis of a Suspected Release instead.

If No Suspected Release is scored, assign the score to factor #2 under Column B and use only Column B for the surface water pathway.

SURFACE WATER PATHWAY TARGETS

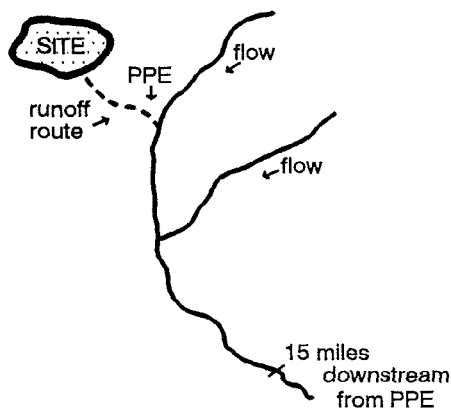
3.4.2 Targets

Surface water pathway targets include intakes that supply drinking water, fisheries, and sensitive environments. Each is evaluated separately. The result is separate scores for three separate threats: Drinking Water Threat, Human Food Chain Threat, and Environmental Threat.

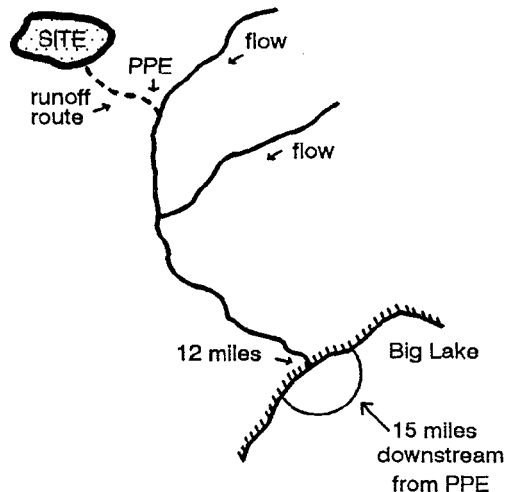
Target Distance Limit

Targets are identified and evaluated over a 15-mile target distance limit, which defines the "in-water segment" of the surface water migration route (in contrast to the "overland segment" which is the runoff route from the site to surface water).

Begin measuring the in-water segment at the probable point of entry (PPE) to surface water, and continue downstream for 15 miles.

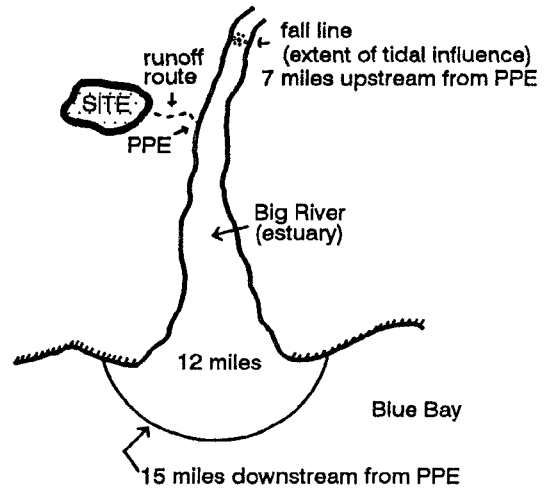


If the 15-mile distance ends in a lake, coastal tidal waters, or ocean, measure the portion of the in-water segment in that water body as an arc from the mouth of the discharging water body and extending to the shores of the receiving water body.

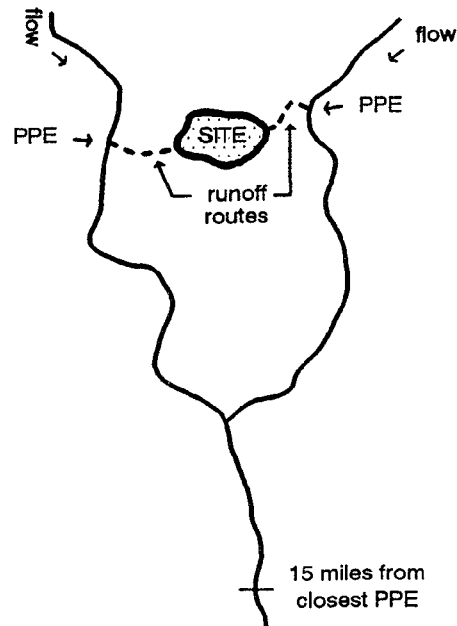


SURFACE WATER PATHWAY TARGETS

If the PPE is to a tidally-influenced water body (e.g., an estuary), the in-water segment extends 15 miles downstream and also extends upstream as far as the tidal run could be expected to carry hazardous substances released from the site (up to a maximum distance of an additional 15 miles).



If runoff from the site enters more than one surface water body, evaluate targets along each in-water segment, out to the target distance limit (as discussed above) measured from each PPE. This may result in two (or more) in-water segments that eventually join and run coincidentally to the target distance limit. In this case, evaluate and score all identified targets to obtain the drinking water, human food chain, and environmental threat scores for the site.

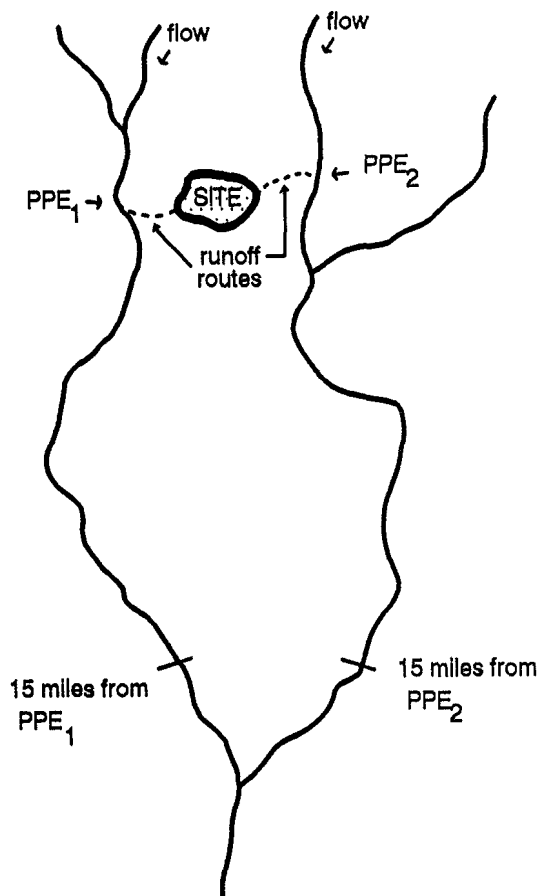


SURFACE WATER PATHWAY TARGETS

Other cases where runoff from the site enters more than one surface water body result in:

- Two or more entirely different in-water segments that do not join within the target distance limit.
- Two or more in-water segments that run coincidentally for part of the distance and diverge for part of the distance, but end the distance divergent (i.e., at the 15-mile point, all in-water segments are not coincident).

In either case, the divergent in-water segments are said to be in different watersheds. Targets associated with each watershed are evaluated separately to arrive at drinking water, human food chain, and environmental threat scores for each watershed. The surface water pathway score is calculated for each watershed, and the highest result is used to score the site.



Drinking Water Threat Targets

Surface water intakes that supply drinking water are targets under the Drinking Water Threat. Identify target intakes, mark the location and extent of the service area of each on a topographic map, determine the flow rate at each intake, and determine the population served by each.

Identifying Drinking Water Intakes

Identify drinking water intakes drawing from water bodies along the in-water segment of the surface water migration route in conjunction with your survey of water supply systems in the vicinity of the site. Section 3.3.2 discusses such a survey in the context of identifying drinking water wells. Except for the target distance limit, the approach to identify drinking water intakes is similar.

Drinking water intakes may serve municipal systems or, less commonly, community systems or individual residences. Identify municipal intakes by telephoning or visiting the municipal water authorities for the communities located along the in-water segment. These officials, or the County

SURFACE WATER PATHWAY TARGETS

Sanitarian or similar Health Department official, can probably also provide information on areas where private community or domestic intakes are used.

Municipal intakes are sometimes identified on topographic maps. Both private and municipal intakes are catalogued in electronic databases such as PATHSCAN, which is maintained by EPA's Office of Water Regulations and Standards (Section 2.4.3). Be aware, however, that sources such as these may be incomplete. Always verify information obtained from databases, especially for completeness, by interviewing knowledgeable local officials.

Transcribe onto the topographic map the locations of all municipal drinking water intakes along the in-water segment and the extent of all distribution systems served by each intake. Also indicate areas on the map where domestic or community intakes are used.

Flow at Target Intakes

Obtain the average flow rate of the stream or lake at the location of each drinking water intake. Flow is expressed in units of cubic feet per second (cfs); average flow is generally calculated over a period of many years. Local water authorities can probably provide you with average flow at or near their own intakes, and may also be able to estimate the flow at or near private intakes.

The USGS operates a nationwide network of gauging stations that record flow on many thousands of water bodies. These data are reported in serialized "Water-Data Reports" published annually by USGS, on a State-by-State basis, and entitled "Water Resources Data, <State name>, Water Year 19 <xx >." Long-term average flow is reported as "average discharge." A gaging station need not be located right by the target intake for published data to be useful. Upstream or downstream gauging stations can be used to approximate flow at the target.

For an intake located on a lake with in-flowing streams, determine flow by summing the average flows of all streams discharging into the lake. For an out-flowing lake without in-flowing streams, sum the flows of all streams leaving the lake. For a closed lake with neither in-flowing nor out-flowing streams, assume a flow rate less than 10 cfs.

Flow is important because secondary target populations are evaluated according to volume of flow available to dilute hazardous substances that may be released from the site. This "dilution weighting" is built into PA Table 3 (page 13 of the PA scoresheets). Note from PA Table 3 that the flow categories increment by orders of magnitude. While it is preferable to obtain actual flow values if they are readily available, in the absence of such data you should be able to estimate average flow within the indicated order-of-magnitude ranges. PA Table 4 lists qualitative descriptions of the different water body types, corresponding to flow rates, that may be useful for estimation purposes.

The "mixing zone" flow category in PA Tables 3 and 4 refers to "quiet-flowing" streams or rivers, as opposed to turbulent flow, with an average flow rate of at least 10 cfs. From PA Table 3, note that this category produces higher dilution-weighted population values than any other category with flow greater than 10 cfs, because quiet-flowing streams or rivers provide less-rapid dispersion and dilution than turbulent flow does. An intake may be evaluated under the mixing zone flow category only if:

- (1) It is located on a quiet-flowing stream or river with a flow rate greater than 10 cfs,
- (2) It is not more than 3 miles from the PPE, and
- (3) The entire reach between the PPE and the intake is quiet-flowing.

SURFACE WATER PATHWAY TARGETS

Evaluating Drinking Water Populations

Establish a drinking water population associated with each intake in the same way as explained in Section 3.3.2 for the ground water pathway. Briefly:

- ! If a municipal water authority cannot provide population figures for its system, multiply the number of service connections by the county average number of persons per household using U.S. Bureau of the Census data.
- ! If any municipal system served by surface water intakes "blends" water from more than one intake, or from a combination of intakes and wells, apportion populations to each intake and well. The same rules of apportionment apply to intakes as to wells (Section 3.3.2), except that "standby" or "backup" wells are not included when evaluating surface water drinking water population (just as standby or backup intakes are not included when evaluating ground water drinking water population).
- ! Evaluate standby or backup intakes for the surface water pathway as discussed for standby or backup wells on page 64; that is, you may either include or exclude them in population apportionment. Select the approach that results in the highest population factor value. In doing so, note that secondary surface water drinking water populations are evaluated on the basis of dilution weighting (in contrast to the distance weighting employed for ground water drinking water populations). In general, this means selecting the approach that results in the largest populations served by intakes drawing from water bodies with the lowest flow rates.
- ! In areas supplied by domestic or community intakes, estimate populations by performing a house count and multiplying the number of counted residences by the county average number of persons per household. Residences may be counted from topographic maps or aerial photographs, or by conducting a windshield survey.
- ! As in the ground water pathway, worker and student populations should always be evaluated in cases where the intake serving such a population is suspected to be exposed to a hazardous substance released from the site (i.e., it is a primary target intake). It is generally not time-efficient, however, to pursue the identification and evaluation of secondary target intakes serving workers or students. Note from PA Table 3 that intakes on water bodies where flow is less than 10 cfs, or in the mixing zone of quiet-flowing streams and rivers with flow rate of at least 10 cfs, begin to achieve large population values when populations served exceed 1,000. For intakes on water bodies in all other flow categories, populations served must exceed 10,000 (for 10 to 100 cfs), 100,000 (for > 100 to 1,000 cfs), or 1,000,000 (for > 1,000 cfs) before significant population values are assigned. Other than municipal water supply, few (if any) intakes will be found that serve such large populations. Consequently, a secondary target intake serving workers or students need not be evaluated unless you believe that it meets the following two requirements:
 - (1) It is located on a water body with average flow rate less than 10 cfs, or in the mixing zone of a quiet-flowing stream or river with average flow rate of at least 10 cfs, and
 - (2) You suspect that the intake serves more than 1,000 people.

SURFACE WATER PATHWAY TARGETS

Human Food Chain Threat Targets

Fisheries are targets under the Human Food Chain Threat. Identify each fishery, and the water body type and flow rate at each fishery, within the target distance limit.

Definition: Fishery -- An area of a surface water body from which food chain organisms are taken or could be taken for human consumption on a subsistence, sporting, or commercial basis. Food chain species include fish, shellfish, crustaceans, amphibians, and amphibious reptiles.

The definition of fishery is intentionally broad and is meant to include any portion of a body of water that does or could provide at least one trout, clam, lobster, frog, or alligator (to name one of each type of animal specified in the definition) for human consumption. In practice, then, water bodies that qualify as fisheries are extremely common. There are some exceptions. Identifying some types of ditches as fisheries, even though they may technically qualify as surface water (see the definition of "stream or river" in the glossary), would defy logic; for example, the ditch may be only intermittently flowing, or may be a perennially-flowing highway drainage ditch. Other examples of "non-fisheries" include water bodies that are sterile for reasons unassociated with the site, and water bodies that are closed to fishing for reasons unassociated with the site (e.g., bacterial or sewage contamination, red tide, contamination from other facilities).

Beginning at the PPE, delineate separate fisheries along the 15-mile in-water segment. One fishery ends and another begins wherever the water body type changes or the water body flow characteristics of a stream or river change. Water body types include:

- ! Streams and rivers
- ! Lakes
- ! Coastal tidal waters
- ! Oceans (includes the Great Lakes)

Each of these water body types are defined in the glossary. Within the "streams and rivers" water body type, flow characteristics are defined by orders of magnitude (see also PA Tables 3 and 4 in the PA scoresheets):

Stream and River Types	Flow Characteristics
Minimal Stream	< 10 cfs
Small to Moderate Stream	10 to 100 cfs
Moderate to Large Stream	> 100 to 1,000 cfs
Large Stream to River	> 1,000 to 10,000 cfs
Large River	> 10,000 cfs
"Quiet-flowing" Mixing Zone	10 cfs or greater

SURFACE WATER PATHWAY TARGETS

Delineating fisheries by water body type is straightforward and can be done by examining the in-water segment on a topographic map. Delineating fisheries by flow characteristics within the "streams and rivers" water body type is more difficult because average flow data are necessary. While actual average flow will often be available at intakes, the data may be less common for fisheries. Lacking actual data from published (USGS) sources or from municipal water authorities, contact local fish and game officials. Obtaining an estimated average flow at any point along the in-water segment will be helpful, as you can use that datum as a starting point for estimating flow in other reaches. If actual flow values cannot be determined, it should be possible to at least estimate within the order-of-magnitude ranges. In fact, you need not expend undue effort trying to obtain flow data because careful estimation is acceptable. Obtaining flow data, for lakes as well as streams and rivers, is discussed on page 89 in conjunction with identifying drinking water intakes.

Environmental Threat Targets

Sensitive environments are targets requiring identification and evaluation under the Environmental Threat. Sensitive environments may be either terrestrial or aquatic but, for surface water pathway purposes, they must lie either in or adjacent to the in-water segment.

Definition: Sensitive Environment -- A terrestrial or aquatic resource, fragile natural setting, or other area with unique or highly-valued environmental or cultural features.

Typically, areas that fall within the definition of "sensitive environment" are established and/or protected by State or Federal law. Examples include National Parks, National Monuments, habitats of threatened or endangered species, and wildlife refuges. A complete list of qualifying sensitive environments is given in PA Table 5 (page 16 of the PA scoresheets).

Identify all sensitive environments in or adjacent to the in-water segment. Many types of sensitive environments are identified and labeled on topographic maps, and this is the best place to begin your survey. Telephone interviews of local fish and game officials, and parks and recreation officials, can also be fruitful. Many States also fund a Natural Heritage Program that inventories and provides information on sensitive environments, recreational areas, natural resources, and so forth. These can be excellent sources of information, but should not be your only source. The Natural Heritage Program is usually housed in the Department of Natural Resources, or similar State agency.

PA Table 5 lists several types of habitat used by State- or Federally-designated endangered or threatened species. Very often, Natural Heritage Programs and other authorities report habitats on a county-wide basis. You may find that a more specific location to answer the question "Does it occur in or adjacent to the in-water segment within the target distance limit?" is not available. Under such circumstances, assume that it does occur along the in-water segment, and score it accordingly.

The soil exposure and air pathways also require you to identify and evaluate sensitive environments, so a comprehensive survey to meet the scoring needs of each pathway should be conducted as a unified task.

Probably the most common type of sensitive environment is the wetland. 40 CFR 230.3(t) provides EPA's wetland definition:

SURFACE WATER PATHWAY TARGETS

Definition: Wetland -- An area that is sufficiently inundated or saturated by surface or ground water to support vegetation adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Many wetlands are identified on topographic maps by the "swamp symbol," but the maps may not show all wetlands. It is a good practice to supplement the topographic map with Wetlands Inventory Maps, which are produced by the U.S. Fish & Wildlife Service (USF&WS) and are available either directly from them or from the State or local agency with fish and wildlife responsibilities. The U.S. Army Corps of Engineers (COE), which has responsibilities pertaining to issuing permits to dredge or fill wetlands and waterways, can also be helpful in identifying wetlands.

For each sensitive environment, identify the water body type that the environment is in or adjacent to, and either obtain or estimate the flow at that environment. Refer to the discussions above (drinking water and food chain threats) for details on obtaining or estimating flow, and remember that order-of-magnitude estimates are acceptable.

With the exception of wetlands, each sensitive environment is assigned a value as indicated in PA Table 5.

For wetlands, measure the total frontage (that portion of the in-water segment that is in contact with wetlands) in each water body type; for the "streams and rivers" water body type, measure the total frontage in each flow characteristics category. Assign a wetlands frontage value from PA Table 6 for each of these frontage totals; for scoring purposes, each of these frontage totals represents a separate environment. In cases where wetlands occur on both sides of a stream or river, measure and sum the total frontage on both sides.

You may encounter situations where two or more sensitive environments overlap. For example, the in-water segment for a particular site passes a 3-mile-long wetland located in a State Wildlife Refuge in a county designated as a critical habitat for the Federally-designated endangered snail darter. In this example, three sensitive environments overlap: the wetland (75 points, PA Table 6), the refuge (75 points, PA Table 5), and the critical habitat (100 points, PA Table 5). If, rather than a county-wide designation, the wetland itself is specifically designated as a critical habitat for the snail darter, the wetland would be assigned 175 points and the refuge 75 points. If the wetland is also a habitat used by bald eagles (another Federally-designated endangered species), it receives an additional 100 points, for a total of 275, while the refuge retains a 75-point value.

Criteria List for Primary Targets

After you have identified all drinking water intakes, fisheries, and sensitive environments located in or adjacent to the in-water segment, and transcribed their locations onto a topographic map, determine which (if any) you consider to be primary targets and which you consider to be secondary.

Identifying a primary target represents a professional judgment, based on site, pathway, and target characteristics, that the target in question has a relatively high likelihood of exposure to a hazardous substance. Secondary targets have a relatively low likelihood of exposure.

SURFACE WATER PATHWAY TARGETS

The Criteria List can help guide the process of developing hypotheses about targets that might be considered primary targets. The right-hand column of the Criteria List identifies a number of target characteristics to consider. Carefully consider each element on the Criteria List for primary targets within the context of the site and its particular targets. Answers to every question on the list, however, are unlikely to be available for many sites. You need not spend excessive amounts of time to develop detailed information to respond to each question -- it is possible to arrive at sound hypotheses about primary targets without knowing the answers to all questions on the list.

Also, keep in mind that there is an infinite variety of conditions that might lead you to identify a primary target, and no list of this type could identify them all. There are likely to be other considerations that may apply to a particular target, and you are encouraged to think along these lines. If such additional considerations enter into your conclusions, identify them at the bottom of the list.

Answer all questions on the list by checking the appropriate box marked "yes," "no," or "unknown." In evaluating each question, rely on all of the information that you have obtained about the site and its targets through the course of your investigation -- file searches, desktop data development, site reconnaissance, interviews, etc.

Answers to many of the questions are likely to be fairly self evident. The difficult part lies in drawing the final conclusion, which amounts to a hypothesis as to whether a particular intake, fishery, or environment is a primary target. This requires professional judgment and is a somewhat intuitive process that relies on your accumulated professional expertise and specific knowledge of site and target characteristics. Answer each of the bottom three questions "yes" or "no" regarding your conclusion whether any specific target may be affected by a release. Note that the Criteria List is not a tally sheet requiring a majority of "yes" or "no" responses to reach a conclusion. You may hypothesize that a particular intake, fishery, or environment is a primary target on the basis of one or more target conditions or site characteristics that lead you to believe there is a relatively high likelihood of a hazardous substance having migrated to the target.

Primary Target Considerations

Each item on the Criteria List for primary targets is briefly discussed below.

Is any target nearby? (If yes, check "drinking water intake," "fishery," and/or "sensitive environment.")

If a release to surface water is suspected, proximity of targets to the site is a significant consideration; the closer the target, the higher the likelihood that it may be exposed to a hazardous substance. Just what qualifies as "nearby" depends on circumstances specific to the site and the water body. Of particular importance are water body type, flow characteristics, and the relative persistence of the hazardous substances you suspect may be associated with the site.

Fast-flowing water bodies can carry hazardous substances further in a shorter period of time than slower-flowing water bodies, so released substances have a greater chance of reaching more distant targets. High-volume flows tend to disperse and dilute contaminants more quickly than low-volume flows, making analytical detection of hazardous substances (during the SI) less likely. The same is true of turbulent flow. This interplay of velocity and volume is further complicated by the persistence of substances that might degrade more or less quickly.

SURFACE WATER PATHWAY TARGETS

These complex interactions mean that little guidance can be given as to what is "nearby" and what is not. You should consider these parameters and make a case-by-case professional judgment as to the likelihood of a particular target being exposed to released substances. It may be helpful to keep in mind that the "proof" of exposure results from analytical sampling that would occur at the SI, and ask yourself if sampling at a particular target would likely reveal contaminants.

Has any intake, fishery, or recreational area been closed?

If water use at or near a target has been curtailed or restricted due to contamination, this could be a strong indicator that it is a primary target -- particularly if there is reason to suspect that the problem is in some way associated with the site. If the reason is unknown, it is best to assume that the problem is associated with the site and evaluate the target accordingly. Exceptions would include conditions such as closure due to bacterial or sewage contamination, red tide, or other problems known to be related to an incident not connected to the site.

Although recreation areas are not specifically evaluated as a separate class of targets, a closed recreation area could provide circumstantial evidence that contamination may exist at nearby intakes, fisheries, or sensitive environments.

Does analytical or circumstantial evidence suggest surface water contamination at or downstream of a target?

"Circumstantial" implies a level of certainty well below that of "proven fact," and this is sufficient for PA purposes. In this context, any condition that you find suspicious, and that indicates a possible contamination problem at or near a target, can be considered "circumstantial evidence." A couple of examples are:

- ! Analytical data indicate a hazardous substance in surface water at or near a target.
- ! The surface water body on which the target is located has been sampled by State, local, or site officials, whether or not you know the results.
- ! A plume, or discolored water or sediment, is present at or near the target.

Does any target warrant sampling? (if yes, check "drinking water intake," "fishery," and/or "sensitive environment.")

Perhaps the most straightforward test to identify primary targets is to ask yourself the question "Given what I know and suspect about this site, would I recommend that this target be sampled (during an SI, for example) with the expectation of detecting hazardous substances there?" If the answer to this question is "yes," you have come to a professional judgment identifying a primary target.

After answering these questions and adding any other considerations to the list, indicate your professional judgment as to the occurrence of primary targets by checking the appropriate box next to each of the three questions at the bottom of the list asking if any primary target(s) have been identified.

To score any target as a primary target, you must first score a suspected release; a release is a precondition to a conclusion that a particular target has a relatively high likelihood of exposure to a

SURFACE WATER PATHWAY TARGETS

hazardous substance. If your evaluation of the Criteria List leads you to believe that one or more targets should be considered primary targets, yet your earlier evaluation of likelihood of release led you to the No Suspected Release hypothesis, you should revisit the Criteria List for suspected releases and reconsider your judgment regarding the likelihood of release.

If your evaluation of the Criteria List leads you to conclude that some targets should be considered primary targets, summarize your rationale and identify the targets.

**SURFACE WATER PATHWAY
DRINKING WATER THREAT
TARGETS**

Factor: Primary Target Population

Definition: The human population served by drinking water drawn from primary target intakes.

Evaluation Strategy: Identifying a primary target intake represents a professional judgment based on site, pathway, and target characteristics indicating a relatively high likelihood that a hazardous substance has migrated to the intake. A primary target may be hypothesized on the basis of available analytical data indicating that the intake may be exposed to hazardous substances; however, analytical data are not usually available for PA sites. For PA purposes, your professional judgment is usually based on indications -- which is not the same as documented fact. You may hypothesize a primary target intake on the basis of one or more characteristics of the site and its environs, sources, and types and quantity of wastes thought to be present, coupled with the proximity of the target and the flow characteristics of the water body on which it is located.

Use the Criteria List for primary targets to guide the process of considering pertinent characteristics that might lead you to identify a primary target intake. The application of the Criteria List is discussed on pages 93 to 96.

It is not possible to provide comprehensive guidance on what does and does not "qualify" as a primary target; you must rely on your professional judgment. Of particular importance in formulating this judgment are the proximity of the intake to the PPE, the flow characteristics (volume, velocity, turbulence) in the interval between the PPE and the intake, and the relative persistence of substances suspected to be associated with the site.

Remember that, in order to evaluate any target as a primary target, a suspected release to surface water must first be scored. In such cases, you may identify both primary and secondary targets. If a release is not suspected, there can be no primary targets.

(continued)

SURFACE WATER PATHWAY DRINKING WATER THREAT TARGETS

Scoring Instructions: Identify each drinking water intake within the target distance limit, the water body type on which each intake is located, and the flow rate of each water body. Enter this information in the box on the drinking water threat scoresheet (page 12 of the PA scoresheets).

Evaluate a drinking water intake as a primary target when available information leads you to hypothesize that there is a relatively high likelihood that a hazardous substance has migrated to the intake.

Determine the population served by each primary target intake as discussed on page 90 and as further described in conjunction with the ground water drinking water population (Section 3.3.2). Briefly:

- ! For each private domestic intake, count the number of persons in households or assign a population equal to the county average number of persons per household using U.S. Bureau of the Census data (round up to the next integer for each household).
- ! For an intake serving more than one residence (community or municipal intakes), determine the number of people served by the intake and assign that population. If the specific number of people served is not available from the operating authority, determine the number of service connections associated with the intake. Multiply this number by the county average number of persons per household (round up to the next integer before multiplying) and assign the resulting population to the intake. Apportion populations if blended systems are served by more than one intake or a combination of wells and intakes, and attach a page to the PA scoresheets to show your calculations.
- ! For an intake serving a distinct non-residential population (a business, industrial park, school, or university, for example), determine the population served by interviewing the intake owner/operator or facility administrator and assign this population to the intake.

Enter the population served by each intake (primary and secondary) in the box under question #3 on the drinking water threat scoresheet (page 12 of the PA scoresheets). Sum the populations served by each primary target intake. Enter the total primary target population on the blank for factor #4 (Primary Target Population). Multiply this total by 10 and enter the resulting factor score under Column A.

If your evaluation of the Criteria List led you to conclude that there are no primary target intakes, assign a zero score to factor #4.

**SURFACE WATER PATHWAY
DRINKING WATER THREAT
TARGETS**

Factor: Secondary Target Population

Definition: The human population served by drinking water drawn from secondary target intakes.

Evaluation Strategy: Just as the identification of primary target intakes represents a professional judgment based on site, pathway, and target characteristics, so is the identification of secondary target intakes. In this instance, however, available information leads you to conclude that the intakes in question have a relatively low likelihood of exposure to a hazardous substance. You base this determination on one or more characteristics of the site and its environs, sources, and types and quantity of wastes thought to be present, coupled with the proximity of the target and the flow characteristics of the water body on which it is located.

Note that, if a release is suspected, some targets may be evaluated as primary targets and some as secondary targets. However, if no release is suspected, all targets are evaluated as secondary targets.

After completing your surface water targets survey and applying the Criteria List, you will have a set of hypotheses identifying the intakes that you believe are secondary targets. Application of the Criteria List is discussed on pages 93 to 96.

Develop separate secondary target population totals for all intakes drawing from water bodies in each flow characteristics category: < 10 cfs; 10 to 100 cfs; > 100 to 1,000 cfs; > 1,000 to 10,000 cfs; > 10,000 cfs (include intakes on the Great Lakes in this category), and mixing zones of quiet-flowing streams and rivers with flow rates of at least 10 cfs. Determine and sum secondary target populations within each flow characteristics category because different weights are applied to populations according to volume of flow to account for the dispersion and dilution of substances that may enter surface water. The weights become smaller with increasing flow rate and water body size to reflect greater dispersion and dilution. This dilution weighting is built into PA Table 3.

When you have completed your target survey and transcribed the locations of municipal and community intakes onto the topographic map, delineated the areas served by municipal, community, and domestic intakes, and obtained or estimated the flow rate at each intake, determining secondary target populations is relatively straightforward. Completing a targets survey, evaluating target populations associated with each intake, apportioning populations in blended systems, and obtaining average flow rates are discussed on pages 88 to 90.

(continued)

SURFACE WATER PATHWAY DRINKING WATER THREAT TARGETS

Scoring Instructions: Evaluate a drinking water intake as a secondary target when available information leads you to conclude that there is a relatively low likelihood of a hazardous substance having migrated to the intake.

Determine the population served by each secondary target intake as discussed on page 90. Briefly:

- ! For each private domestic intake, assign a population equal to the average number of persons per household for the county using data from the U.S. Bureau of the Census (for secondary target populations, do not round the average up to the next integer).
- ! For an intake serving more than one residence (community or municipal intake), determine the number of people served by the intake and assign that population to the intake. If the specific number of people served is not available from the authority operating the intake, determine the number of service connections associated with the intake. Multiply this number by the county average number of persons per household (do not round the average up to the next integer) and assign the resulting population to the intake. Apportion populations if necessary.
- ! For intakes serving a distinct non-residential population (a business, industrial park, or university, for example), determine the population served by interviewing the intake owner/operator or facility administrator and assign that population to the intake. Recall the discussion of dilution weighting of secondary target populations (pages 89 and 90) and PA Table 3; you need not pursue the identification and evaluation of private or community intakes serving residences, workers, or students unless you believe that a particular intake is located on a water body with average flow rate less than 10 cfs, or in the mixing zone of a quiet-flowing stream or river with average flow rate greater than 10 cfs, and you suspect that the intake serves more than 1,000 people.

For each flow characteristics category, sum the population served by secondary target intakes. Using PA Table 3 (page 13 of the PA scoresheets) for each flow category with secondary target intakes:

- 1) Enter the secondary target population for the flow category in the "Population" column.
- 2) Working horizontally across the table, circle the value in the same row that represents the range into which the flow-category population falls.
- 3) Record the circled value in the same row of the "Population Value" column.

Sum the population values in the far-right column. Record this total at the bottom of the column and in one of the blanks for factor #5 (Secondary Target Population) on the drinking water threat scoresheet. Use the blank under Column A if "Suspected Release" was scored for the Likelihood of Release factor category; use the blank under Column B if "No Suspected Release" was scored. Mark your response to the question "Are any intakes part of a blended system?". If you have apportioned populations, attach a page to the PA scoresheets to show your calculations.

**SURFACE WATER PATHWAY
DRINKING WATER THREAT
TARGETS**

Factor: Nearest Intake

Definition: The drinking water intake closest to the probable point of entry to surface water.

Evaluation Strategy: In addition to evaluating both primary and secondary target populations, the PA also evaluates the distance to the nearest drinking water intake. This distance is an indicator of the magnitude of the threat the site may pose to surface water users. All other considerations being equal, the closer an intake is to the site and the lower the water body flow at the intake, the higher the threat the intake might be exposed to a hazardous substance.

Annotate the topographic map to identify the nearest target intake. A map wheel or calibrated string can be used to determine the distance between that intake and the PPE; record this distance in the "Pathway Characteristics" box at the top of the drinking water threat scoresheet. The number you record should be an absolute number, not a range, and accurate to the nearest 0.1 mile. Determine the flow rate at the intake; flow rates are discussed on page 89 and are determined as part of the surface water pathway targets survey.

Scoring Instructions: If you have identified any primary target intake you have, in effect, hypothesized that the threat or likelihood of exposure is relatively high. For this reason, whenever a primary target intake is present, assign a score of 50 to the Nearest Intake factor under Column A, regardless of distance or flow rate.

Otherwise, from PA Table 3 (page 13 of the PA scoresheets), select the flow characteristics category in which the nearest secondary target intake is located (far-left column). Circle the value on the same line in the column labeled "Nearest Intake." Record the selected value in one of the blanks for factor #6 (Nearest Intake) on the drinking water threat scoresheet. Use the blank under Column A if you scored "Suspected Release" for the Likelihood of Release factor category; use the blank under Column B if you scored "No Suspected Release."

SURFACE WATER PATHWAY DRINKING WATER THREAT TARGETS

Factor: Resources

Definition: Use of surface water for purposes other than drinking water.

Evaluation Strategy: In addition to providing drinking water, surface water is often used for other purposes that could affect human health:

- ! Irrigation (5 acre minimum) of commercial food crops or commercial forage crops.
- ! Watering of commercial livestock.
- ! Ingredient in commercial food preparation (e.g., canning plant).
- ! Major or designated water recreation area (e.g., boat ramp, marina).
- ! Potential usability as drinking water supply, though the resource is not currently used for drinking water.

The PA accounts for such use through the resources factor, which is assigned a value of 5 if any of the above resource uses are present within the 15-mile in-water segment; a zero value is assigned if there is no resource use.

Since surface water often has some beneficial use, the resources factor can generally be assigned 5 points as a default measure. This approach is conservative from the scoring perspective (as the maximum value is assigned), has little impact on the pathway and site score, and can potentially save you many hours of research trying to define crop acreage, "commercial" uses, "major or designated" areas, and "usability."

Scoring Instructions: If, within the target distance limit, surface water is used for any of the purposes itemized above, assign a score of 5 to one of the blanks for factor #7 (Resources) on the surface water pathway scoresheet; otherwise, assign a zero value. Alternatively, simply assign the 5 point value as a default measure. Use the blank under Column A if you scored a "Suspected Release" for the Likelihood of Release factor category; use the blank under Column B if you scored "No Suspected Release."

Total Drinking Water Threat Targets: Calculate the Drinking Water Threat Targets factor category score by summing the scores assigned to factors #4 through 7. Factor scores should appear in only one of the two columns (A or B) depending on whether you scored a suspected release.

**SURFACE WATER PATHWAY
HUMAN FOOD CHAIN THREAT
TARGETS**

Factor: Primary Target Fisheries

Definition: Fisheries suspected to be exposed to a hazardous substance released from the site.

Evaluation Strategy: The identification of primary target fisheries is analogous to that for primary target intakes; refer to the "Evaluation Strategy" for primary target population on page 97.

Scoring Instructions: Delineate each fishery (primary and secondary) within the target distance limit (see pages 91 to 92). For each, enter a fishery name, its water body type, and flow rate in the box on the human food chain threat scoresheet (page 14 of the PA scoresheets). If there is no fishery (primary or secondary), assign a zero score for human food chain threat targets at the bottom of the page.

Evaluate a fishery as a primary target when available information leads you to conclude that there is a relatively high likelihood that a hazardous substance has migrated to the fishery. If you have identified one or more primary target fisheries, list them under factor #9 (Primary Fisheries) and assign a single score of 300 to the factor under Column A. Carry this score to the bottom of the page as the Human Food Chain Threat Targets score (do not evaluate factor #10, Secondary Fisheries).

If you identified no primary target fisheries, assign a zero score to factor #9.

SURFACE WATER PATHWAY HUMAN FOOD CHAIN THREAT TARGETS

Factor: Secondary Target Fisheries

Definition: Fisheries not suspected to be exposed to hazardous substances released from the site.

Evaluation Strategy: This factor need only be evaluated if you have not identified a primary target fishery. The identification of secondary target fisheries is analogous to that for secondary target intakes; review the first three paragraphs of the "Evaluation Strategy" for secondary target population on page 99.

Unless a release is suspected, secondary target fisheries are scored on the basis of flow rate. Because low-flow water bodies have less ability to disperse and dilute hazardous substances than do high-flow water bodies, this factor is scored on the basis of the fishery with the lowest flow rate.

Scoring Instructions: Delineate each fishery (primary and secondary) within the target distance limit (see pages 91 to 92). For each, enter a fishery name, its water body type, and flow rate in the box on the human food chain threat scoresheet (page 14 of the PA scoresheets). If there is no fishery (primary or secondary) within the target distance limit, assign a zero score for human food chain threat targets at the bottom of the page.

Evaluate a fishery as a secondary target when available information leads you to conclude that there is a relatively low likelihood that a hazardous substance has migrated to the fishery.

If you suspect a release to surface water, but do not suspect that a hazardous substance has migrated to any fishery (i.e., you have identified one or more secondary target fisheries but have not identified any primary target fishery), assign a score of 210 to factor #10a (Secondary Fisheries). Assign the score under Column A and carry it to the bottom of the page as the Human Food Chain Threat Targets score.

If you do not suspect a release to surface water, identify the fishery with the lowest flow rate. Assign a single score to factor #10b from the table on the human food chain threat scoresheet. Assign a score of 210 if the lowest flow rate is less than 10 cfs; 30 if between 10 and 100 cfs; or 12 if greater than 100 cfs, or if fisheries are only located in coastal tidal waters, oceans, or the Great Lakes. Assign the score under Column B and carry it to the bottom of the page as the Human Food Chain Threat Targets score.

**SURFACE WATER PATHWAY
HUMAN FOOD CHAIN THREAT
TARGETS**

Factor: Primary Target Sensitive Environments

Definition: Sensitive environments suspected to be exposed to a hazardous substance released from the site.

Evaluation Strategy: The identification of primary target sensitive environments is analogous to that for primary target intakes; refer to the "Evaluation Strategy" for primary target population on page 97.

Scoring Instructions: Identify each sensitive environment (primary and secondary) in or adjacent to the in-water segment within the target distance limit (see pages 92 to 93 and PA Table 5, page 16 of the PA scoresheets). For each, enter an environment name, its water body type, and flow rate in the box under item #11 on the environmental threat scoresheet (page 15 of the PA scoresheets). If there are no sensitive environments (primary or secondary), assign a zero score for environmental threat targets at the bottom of the page.

Evaluate a sensitive environment as a primary target when available information leads you to conclude that there is a relatively high likelihood that a hazardous substance has migrated to that environment. If you have identified one or more primary target sensitive environments, list them on the blanks provided by factor #12 (Primary Sensitive Environments) and assign a single score of 300 to the factor under Column A. Carry this score to the bottom of the page as the Environmental Threat Targets score (do not evaluate factor #13, Secondary Sensitive Environments).

If you identified no primary target sensitive environments, assign a zero score to factor #12.

SURFACE WATER PATHWAY HUMAN FOOD CHAIN THREAT TARGETS

Factor: Secondary Target Sensitive Environments

Definition: Sensitive environments not suspected to be exposed to hazardous substances released from the site.

Evaluation Strategy: This factor need only be evaluated if you have not identified a primary target sensitive environment. The identification of secondary target sensitive environments is analogous to that for secondary target intakes; review the first three paragraphs of the "Evaluation Strategy" for secondary target population on page 99.

Secondary target sensitive environments are scored on the basis of flow rate, because low-flow water bodies have less ability to disperse and dilute hazardous substances than do high-flow water bodies. Possible scoring scenarios include: situations where some or all of the surface water pathway secondary sensitive environments are located in or adjacent to water bodies with flow rates of 100 cfs or less; and situations where all surface water pathway sensitive environments are located in or adjacent to water bodies with flow rates exceeding 100 cfs.

Scoring Instructions: Identify each sensitive environment (primary and secondary) in or adjacent to the in-water segment within the target distance limit (see pages 92 to 93 and PA Table 5, page 16 of the PA scoresheets). For each, enter an environment name, its water body type, and flow rate in the box under item #11 on the environmental threat scoresheet (page 15 of the PA scoresheets). If there are no sensitive environments (primary or secondary), assign a zero score for environmental threat targets at the bottom of the page.

Evaluate a sensitive environment as a secondary target when available information leads you to conclude that there is a relatively low likelihood that a hazardous substance has migrated to that environment.

For each surface water pathway sensitive environment associated with a water body having a flow rate of 100 cfs or less, identify the environment type, its point value (PA Tables 5 and 6, page 16 of the PA scoresheets), and its flow rate. Enter this information in the box under factor #13a. For each such environment, use PA Table 4 (page 13 of the PA scoresheets) to obtain a dilution weight corresponding to its flow category (1 or 0.1, as appropriate). Enter the dilution weight for each environment in the box under factor #13a. For each environment, multiply its assigned point value by the appropriate dilution weight, and enter the product in the box under the column labeled "Total." Sum the products for each environment, round the sum to the nearest integer, and enter the result as the score for factor #13a (Secondary Sensitive Environments). Assign the score under Column A if you scored a suspected release; under Column B if you did not. Do not evaluate factor #13b.

(continued)

**SURFACE WATER PATHWAY
ENVIRONMENTAL THREAT
TARGETS**

If all surface water pathway sensitive environments are associated with water bodies having flow rates greater than 100 cfs, do not evaluate factor #13a. Instead, assign a single score of 10 to factor #13b. Assign the score under Column A if you scored a suspected release; under Column B if you did not.

SURFACE WATER PATHWAY WASTE CHARACTERISTICS AND THREAT AND PATHWAY SCORES

3.4.3 Waste Characteristics

The evaluation of the Waste Characteristics factor category is discussed in Section 3.2.2.

If you have identified any primary target drinking water intake, fishery, or sensitive environment, assign either the waste characteristics score (WC) that you calculated using PA Table 1 (Section 3.2.2, and page 4 of the PA scoresheets) or a score of 32--whichever is greater--to factor #14a. Assign this score under Column A. Do not evaluate factor #14b.

If you have not identified any primary target, assign the waste characteristics score (WC) that you calculated using PA Table 1 (Section 3.2.2, and page 4 of the PA scoresheets) to factor #14b. Assign the score under Column A if you scored "Suspected Release" for likelihood of release; under Column B if you scored "No Suspected Release." Do not evaluate factor #14a.

3.4.4 Calculating Surface Water Threat and Pathway Scores

Calculate separate scores for the drinking water, human food chain, and environmental threats, then combine them to obtain the surface water pathway score.

Fill in the matrix on page 17 of the PA scoresheets with the appropriate values for likelihood of release (LR), targets (T), and waste characteristics (WC) for each threat. Note that LR and WC are the same for all threats; only T may differ for each threat. Calculate the score for each threat and enter it in the far-right column of the matrix: multiply $LR \times T \times WC$, divide the product by 82,500, and round to the nearest integer. The drinking water and food chain threats are each subject to a maximum score of 100; if the score you calculate exceeds 100, assign 100 as the threat score. The environmental threat is subject to a maximum score of 60; if the score you calculate exceeds 60, assign 60 as the threat score.

Sum the drinking water, human food chain, and environmental threat scores. Record the result as the surface water pathway score at the bottom of the page. If your calculated score exceeds 100, assign 100 as the pathway score.

3.5 SOIL EXPOSURE PATHWAY

The soil exposure pathway assesses the threat to human health and the environment by direct exposure to hazardous substances and areas of suspected contamination. This pathway differs from the three migration pathways in that it accounts for contact with in-place hazardous substances at the site, rather than migration of substances from the site.

The PA evaluation of the soil exposure pathway requires you to consider and assign scores to factors in three factor categories. The first, Likelihood of Exposure, is analogous to Likelihood of Release in the other pathways. Targets are evaluated under two threat categories. The resident population threat deals with human, environmental, and resource targets located on or very near the site. The nearby population threat accounts for the likelihood of residents within the surrounding area coming into contact with contamination related to the site. The evaluation and score for the Waste Characteristics factor category (WC, Section 3.2.2) applies directly to the soil exposure pathway, without exceptions.

SOIL EXPOSURE PATHWAY LIKELIHOOD OF EXPOSURE

3.5.1 Likelihood of Exposure

The Likelihood of Exposure factor category is concerned with areas of suspected contamination. While this evaluation occurs in the context of the soil exposure pathway, areas of suspected contamination are not limited to soils; any sources, areas of contamination, or other material on the surface is considered (e.g., gravel fill, waste pile, plank flooring, concrete, asphalt paving).

Areas of suspected contamination are defined by the presence of hazardous substances. Thus, in general, most sources (including in-ground sources such as surface impoundments and landfills, on-ground sources such as contaminated soil and piles, and above-ground sources such as drums and tanks) are considered areas of suspected contamination. There are two types of exceptions:

- ! Sources with more than 2 feet of cover.
- ! Sources with an impenetrable cover (e.g., asphalt paving), regardless of thickness.

The evaluation of this factor category functions as an "on/off" switch. A score of 550 is assigned if you know or suspect that an area of contamination is present; a zero score is assigned if there are no areas of contamination. Areas of suspected contamination are present at most CERCLA sites. Occasionally, however, you may encounter sites with no areas of contamination. Examples may include:

- ! A ground water plume site with no identifiable source
- ! A closed landfill with a 3-foot-thick clean fill cover
- ! A site that has been completely paved with 4 inches of asphalt
- ! A site where the only source is inside a building

Even with sites such as these, it may be difficult to rule out the presence of areas of suspected contamination with information available during a PA. For example:

- ! For a plume site, while a source may not be visually identifiable, one may be revealed through surface sampling.
- ! For a site involving clean cover material greater than 2 feet thick, uneven distribution of the material, subsequent erosion, or leachate breakouts could result in areas of suspected contamination.
- ! For a paved site, areas of suspected contamination may be present atop the pavement itself. Or, prior to paving, runoff may have carried hazardous substances onto adjoining areas that have not been paved.
- ! For a source inside a building, areas of suspected contamination may exist on the flooring.

To confidently rule out the presence of areas of suspected contamination, appropriate quality analytical data demonstrating the absence of hazardous substances are generally necessary. For this reason, and because areas of contamination are present at most CERCLA sites, you may generally assume this to be the case and assign a value of 550 for Likelihood of Exposure. To assign the alternative zero value, which effectively eliminates the soil exposure pathway from further consideration, you generally need analytical data that confidently demonstrate the absence of areas of contamination. Review Section 3.1 for a discussion of potential limitations in applying available analytical data. Also refer to Section 5.3 for a discussion of evaluating available analytical data to determine whether they meet the test of appropriate quality.

SOIL EXPOSURE PATHWAY LIKELIHOOD OF EXPOSURE

Factor: Suspected Contamination

Definition: Known or suspected areas of contamination; that is, areas containing hazardous substances not covered by either an essentially impenetrable cover or more than 2 feet of cover material.

Evaluation Strategy: Because areas of suspected contamination are usually present at CERCLA hazardous waste sites, a Likelihood of Exposure score of 550 is generally appropriate and you may assign this value as a default measure. Assign the alternative zero value only in cases where the presence of areas of contamination can be confidently ruled out. To do this, appropriate quality analytical data are usually necessary. Refer to Sections 3.1 and 5.3 for discussions regarding available analytical data and the conditions under which such data may be considered appropriate quality.

Scoring Instructions: If available analytical data confidently rule out the presence of areas of suspected contamination, assign a zero score to factor #1 (Suspected Contamination) on the soil exposure pathway scoresheet (page 19 of the PA scoresheets). Due to the multiplicative algorithm for pathway scoring (Likelihood of Exposure x Targets x Waste Characteristics), this effectively eliminates further consideration of the soil exposure pathway; therefore, assign zero as the pathway score at the bottom of the page.

Otherwise, or as a default measure, assign a score of 550 to factor #1.

SOIL EXPOSURE PATHWAY TARGETS

3.5.2 Targets

Soil exposure pathway targets involve two separate threats:

- ! The resident population threat evaluates targets located on or within 200 feet of areas of suspected contamination. Factors include resident population, resident individual, workers, terrestrial sensitive environments, and resources.
- ! The nearby population threat represents a separate threat to the population in the surrounding vicinity.

Keep these targets in mind as you investigate the site and its environs during the site reconnaissance (Section 2.5). For many of these target factors, first-hand observation will likely prove more fruitful and accurate than site file records, existing photographs, and topographic maps. During the reconnaissance, observe and verify the current use of the site property, and the location of onsite buildings and nearby homes, residential developments, schools, and daycare facilities.

Resident population, resident individual, workers, and terrestrial sensitive environments are identified and evaluated on the basis of their presence on, or their distance from, areas of suspected contamination. The key to identifying and evaluating these targets, then, is to delineate sources completely and thoroughly.

Recall the definition of the term "source."

Definition: Source -- An area where a hazardous substance may have been deposited, stored, disposed, or placed. Also, soil that may have become contaminated as a result of hazardous substance migration.

By carefully identifying and delineating sources, you define the maximum extent of suspected contamination; targets are evaluated on the basis of their distance from these areas. Refer to "Source Identification and Characterization" in Section 3.2.1 for further discussion, and remember that the extent of suspected contamination is not limited by facility property boundaries.

Identifying Resident Population

The resident population factor represents the human population with the highest risk of exposure to hazardous substances at the site. This population is potentially exposed on an essentially daily basis because they either live or attend school or daycare in areas where hazardous substances may be present. This "resident population" is analogous to "primary targets" in the three migration pathways. Resident population targets meet either of the following conditions:

- ! A person who resides on or within 200 feet of an area of suspected contamination.
- ! A person who attends school or daycare on or within 200 feet of an area of suspected contamination.

Areas of suspected contamination are not limited to the property boundaries of the facility itself -- they may occupy less than the total area of the facility, or may extend onto adjacent and other

SOIL EXPOSURE PATHWAY TARGETS

nearby properties. Hazardous substances may have spread from the facility to other properties via air migration, overland runoff, or mechanical means such as tracking by vehicles.

Investigate whether the facility property previously encompassed a greater area than the current area of operations or property boundaries. Sources of information include facility operating files, former employees, and historical aerial photographs. The local tax assessor's office will have a complete historical record of the sale, acquisition, and transfer of all real estate; this is an excellent and reliable source of detailed information including dates of property transfer and real estate development activities. If surrounding properties include residences or schools, find out from the tax assessor when they were built. By comparing these dates to the operating history of the site, you may find, for example, that houses have been built on former waste disposal areas that are no longer discernible because they have been developed. People living in those houses would be considered resident population.

When identifying schools and daycare facilities whose attendees may be considered resident population, include all types of public and private institutions. In addition to nursery schools, elementary and secondary schools, and colleges and universities, also consider adult daycare facilities, adult education centers, driving schools, and so forth.

Criteria List for Resident Population

After delineating the full extent of areas of suspected contamination, identify nearby residences and schools on or within 200 feet of suspected contamination.

Review the Soil Exposure Pathway Criteria List (page 18 of the PA scoresheets). The Criteria List can help guide the process of developing hypotheses about the extent of suspected contamination and the presence of resident population targets. The Criteria List identifies conditions to consider in reaching these conclusions, but other conditions may apply to a particular site that might lead you to identify a resident population, and you are encouraged to think along these lines. If such additional considerations enter into your conclusions, identify them at the bottom of the list.

Answer all questions on the list by checking the appropriate box marked "yes," "no," or "unknown." In evaluating each question, rely on all of the information you have obtained about the site and its targets through the course of your investigation -- file searches, desktop data collection, site reconnaissance, interviews, etc. Answer the bottom question "yes" or "no" regarding your conclusion whether a specific target may be on or within 200 feet of an area of suspected contamination.

Resident Population Considerations

Each item on the Criteria List for resident population targets is briefly discussed below.

Is any residence, school, or daycare facility on or within 200 feet of an area of suspected contamination?

Identifying areas of suspected contamination is the key to identifying resident populations. This requires a thorough delineation of sources -- which includes areas that you suspect may be contaminated as a result of hazardous substance migration.

Do not rely solely on topographic maps to identify houses and school buildings because they may not be up to date. During your site reconnaissance, look for homes, residential

SOIL EXPOSURE PATHWAY TARGETS

developments, trailer parks, apartment buildings, schools, daycare facilities, and other new development that may not be indicated on your maps. Persons who live or attend school or daycare on or within 200 feet of areas of suspected contamination qualify as resident population targets.

Is any residence, school, or daycare facility located on adjacent land previously owned or leased by the site owner/operator?

Over time, portions of the original facility property may have been sold, or adjacent property might at one time have been leased for facility operations. If so, hazardous substances may be present on those properties. You need not expend undue effort to definitively conclude that hazardous substances were handled on, or migrated to, those areas; it may be enough to know or suspect that these properties could have been involved in facility operations or that contamination could have been tracked or migrated there.

Is there a migration route that might spread hazardous substances near residences, schools, or daycare facilities?

Consider whether a runoff route from the site could result in soil or sediment contamination on or near residential or school property. Also consider windblown transport -- especially if your evaluation of the air pathway likelihood of release led to a hypothesis that an air release is suspected (Section 3.6.1). In addition, consider whether waste hauling vehicles may have traversed properties that are now occupied by residences, schools, or daycare facilities. Related considerations include any reports or observations of stained soil or stressed vegetation on nearby properties.

Have onsite or adjacent residents or students reported any adverse health effects, exclusive of apparent drinking water or air contamination problems?

The local Health Department or other authorities may have reports of adverse health effects - such as skin burns or rashes after yard work or outdoor play -- that might be associated with contact with hazardous wastes or contaminated soil related to the site.

Does any neighboring property warrant sampling?

Perhaps the most straightforward test to identify potential resident population targets is to ask yourself the question "Given what I know and suspect about the sources and the history of this site, would I recommend that this neighboring property be sampled (during an SI, for example) with the expectation that I might find hazardous substances there?" If the answer to this question is "yes," you have come to a professional judgment and you may have identified resident population targets if schools, daycare facilities, or residences are within 200 feet of the area of suspected contamination.

Other criteria?

There may be other criteria that support the identification of areas of suspected contamination and the presence of resident population targets. These might include consideration of releases via the migration pathways if, for example, releases are suspected to have resulted in soil contamination on adjacent or nearby offsite properties. Has the site flooded, or have sources (such as surface impoundments) overflowed onto adjacent properties? Might windblown substances released from the site have been deposited on nearby properties? These additional

SOIL EXPOSURE PATHWAY TARGETS

questions may not apply to all sites; likewise, there may be other considerations specific to the site you are evaluating.

After answering these questions and adding any other considerations to the list, indicate your professional judgment as to the occurrence of resident population targets by checking the appropriate box next to the "Resident Population Identified?" question.

If your evaluation of the Criteria List leads you to conclude that any residence, school, or daycare facility should be evaluated for resident population, summarize your rationale and identify the specific targets.

Evaluating Resident Populations

Determine the number of persons occupying residences that qualify as resident population targets. If possible, obtain a count of residents by conducting a door-to-door survey. Be aware of potential community relations concerns and do not undertake a door-to-door survey without first consulting your supervisors. Alternatively, obtain the county average number of persons per household from the U.S. Bureau of the Census. Round up to the next whole number of persons for each residence, and multiply the number of households considered resident population targets by the county average. Houses that are used as seasonal residences (for example, summer cottages, winter homes, lake or beach houses) should be evaluated just as year-round places of residence are.

For apartments or condominiums, contact the building superintendent or leasing/sales agent to obtain the number of residential units in the building. Multiply the number of units by the county average number of persons per household, first rounding the average up to the next integer.

Determine the enrollment or attendance at schools and daycare facilities regarded as resident population targets by contacting the facility administrator. Remember to consider all types of educational institutions.

Identifying and Evaluating Workers

The resident population threat includes an evaluation of workers on the facility property and workers on the property of nearby facilities where you also suspect contamination related to the site. This addresses the threat to workers who may be exposed to hazardous substances by virtue of being present at the workplace. If some workers also reside on the facility property, or on neighboring properties where you suspect contamination, count them under both the worker category and the resident population category. Do not be concerned about "double counting," for that is the intent -- such persons are doubly exposed.

Include both full-time and part-time workers in the count. If the facility is engaged in shift work, count all workers on all shifts.

If the site is active, you may be able to determine the number of workers through file searches, or by interviewing a facility representative, or present or former employees. If you cannot determine the number of workers by these means, estimate a reasonable number for a facility of this size and type.

Note from page 19 of the PA scoresheets that workers are scored in ranges of 0, 1 to 100, 101 to 1,000, and greater than 1,000. In the absence of an exact figure, careful estimation within these ranges is acceptable. You may be able to make an estimate based on your site reconnaissance.

SOIL EXPOSURE PATHWAY TARGETS

Counting the number of employee parking spaces is an acceptable means of approximating the right range. Aerial photographs may also indicate personal vehicles in employee parking lots, which you may count, if feasible. However, do not evaluate the number of workers that might have been employed at the facility in the past, unless this number is also a good approximation of the number currently employed.

Identifying and Evaluating Terrestrial Sensitive Environments

As with the resident population factor, identifying sensitive environments for the soil exposure pathway requires a clear delineation of land areas where you suspect contamination by site-related hazardous substances. You then evaluate the presence of terrestrial sensitive environments on those areas of suspected contamination. Because, under the soil exposure pathway, some portion of a sensitive environment must occur on an area of suspected contamination, qualifying environments are analogous to primary sensitive environments under the surface water and air pathways.

Definition: Terrestrial Sensitive Environment -- A terrestrial resource, fragile natural setting, or other area with unique or highly-valued environmental or cultural features.

Typically, areas that fall within the definition of "terrestrial sensitive environment" are established and/or protected by State or Federal law. Examples include National Parks, National Monuments, habitats of threatened or endangered species, and wildlife refuges. Note that, while your evaluation of sensitive environments under the surface water and air pathways includes both terrestrial and aquatic environments, the soil exposure pathway evaluation is limited to terrestrial sensitive environments. PA Table 7 (page 20 of the PA scoresheets) lists sensitive environments applicable to the soil exposure pathway.

Identify terrestrial sensitive environments as part of a unified task to identify sensitive environments for the surface water, soil exposure, and air pathways. Many types of sensitive environments are identified and labeled on topographic maps, and this is the best place to begin your survey. Telephone interviews of local fish and game officials, and parks and recreation officials, can also be fruitful. Many States also fund a Natural Heritage Program that inventories and provides information on sensitive environments, recreational areas, natural resources, and so forth. These can be excellent sources of information, but should not be your only source. The Natural Heritage Program is usually housed in the State Department of Natural Resources, or similar State agency.

PA Table 7 lists several types of habitat used by State- or Federally-designated endangered or threatened species. Very often, Natural Heritage Programs and other authorities that inventory such habitats report their occurrence on a county-by-county basis. You may find that a more specific location to answer the question "Does it occur on an area of suspected contamination associated with the site?" is not available. Under such circumstances, it is best to assume that it does occur on an area of suspected contamination and score it accordingly.

Consider the following example: You find from the State Department of Natural Resources that the county in which the site is located is specified as terrestrial habitat used by the State-designated threatened snowshoe hare and spotted groundhog. You wonder if the "entire county" designation is specific enough to indicate that the habitats are likely to be on the site itself. A colleague

SOIL EXPOSURE PATHWAY TARGETS

remembers that, in the past, the office consensus was to score this environment only if you observed and photographed the threatened species during site assessment field activities. However, your site reconnaissance occurred on a snowy January day, during which you could not see a snowshoe hare because of its natural coloration, and the groundhog was still hibernating (Groundhog Day is February 2). For PA purposes, the county-wide designation is sufficient to assign 50 points (PA Table 7) for the snowshoe hare and 50 points for the spotted groundhog, obtaining a score of 100. This example also illustrates that, as with sensitive environments under the surface water and air pathways, the score for soil exposure terrestrial sensitive environments is cumulative for multiple designations.

SOIL EXPOSURE PATHWAY TARGETS

Factor: Resident Population

Definition: Persons living or attending school or daycare on or within 200 feet of suspected contamination.

Evaluation Strategy: Resident population consists of those people likely to be most highly exposed to hazardous substances in areas of suspected contamination. They are subject to exposure because they live, or attend school or daycare, on or very near areas of suspected contamination.

The evaluation of resident population requires careful identification and delineation of sources. Do this in conjunction with your evaluation of waste quantity and waste characteristics (Section 3.2.2). Identifying sources and delineating areas of suspected contamination involves a combination of quantitative evidence and professional judgment. Remember that areas of suspected contamination include areas to which hazardous substances may have migrated -- this may be less than the total area of the facility property itself, or may extend onto neighboring properties.

With all areas of suspected contamination delineated, resident populations are identified on the basis of distance from those areas of suspected contamination. Resident population includes:

- ! Any person who resides on or within 200 feet of an area of suspected contamination.
- ! Any person who attends school or daycare on or within 200 feet of an area of suspected contamination.

You may hypothesize a resident population on the basis of available analytical data indicating that people live or attend school or daycare on or within 200 feet of hazardous substances; however, analytical data are not usually available for PA sites. For PA purposes, your professional judgment is usually based on indications -- which is not the same as documented fact. Fully documented areal distribution of contamination usually cannot be achieved at the PA.

When delineating areas of suspected contamination and identifying resident population targets, consider characteristics of the sources at the facility, the capability for migration to neighboring properties, and the proximity of the target itself. When available information leads to the conclusion that there is a relatively high likelihood of a hazardous substance within 200 feet of a residence, school, or daycare facility, you have identified a resident population.

Use the Criteria List for resident population targets to guide the process of considering pertinent characteristics that might lead you to suspect a resident population. The application of the Criteria List is discussed on pages 113 to 115.

(continued)

SOIL EXPOSURE PATHWAY TARGETS

Scoring Instructions: Determine the number of people occupying residences that qualify as resident population targets. Obtain a count by conducting a door-to-door survey if community relations considerations allow and if your supervisors concur. Alternatively, obtain the county average population per household from the U.S. Bureau of the Census, round this average up to the next integer, and multiply the result by the number of residences identified as resident population targets.

For apartment and condominium buildings, multiply the number of residential units by the county average as described above.

For schools or daycare, obtain an enrollment figure from the facility's administration office. Remember to consider all types of educational institutions.

Sum the number of persons determined as discussed above. Enter the total population on the blank by factor #2 (Resident Population) on the soil exposure pathway scoresheet (page 19 of the PA scoresheets). Multiply this total population by 10 and enter the resulting factor score.

If your evaluation of the Criteria List led you to conclude that there is no resident population, assign a zero score to factor #2 (Resident Population) and factor #3 (Resident Individual).

SOIL EXPOSURE PATHWAY TARGETS

Factor: Resident Individual

Definition: Any resident population target.

Evaluation Strategy: The resident individual factor reflects the fact that the simple presence of a resident population means that at least one person is potentially threatened by proximity to hazardous substances in areas of suspected contamination. This factor is analogous to the nearest well, intake, and individual factors of the other three pathways. Because resident populations are analogous to primary targets under the other three pathways, the resident individual factor receives the maximum score if a resident population is present; it scores zero otherwise.

Scoring Instructions: If you have identified any resident population (factor #2), assign a score of 50 to the resident individual factor (factor #3). If there is no resident population, assign a score of zero.

SOIL EXPOSURE PATHWAY TARGETS

Factor: Workers

Definition: Full- or part-time employees.

Evaluation Strategy: This factor addresses the threat to workers who may be exposed to hazardous substances because they are present at the workplace. If the facility is active, determine the number of workers by contacting a facility representative, interviewing present or former employees, or through file information. Lacking an exact number, make a reasonable estimate for a facility of this size and type. If the facility involves shift work, count all workers on all shifts. Count the workers at neighboring facilities only if you suspect that hazardous substances have migrated there.

Scoring Instructions: Assign a score to factor #4 (Workers) from the table printed on the soil exposure pathway scoresheet. Assign the score that corresponds to the total number of workers at the facility (and at affected neighboring facilities, if appropriate). Do not evaluate workers who might have been employed at the facility in the past.

SOIL EXPOSURE PATHWAY TARGETS

Factor: Terrestrial Sensitive Environments

Definition: Terrestrial resources, fragile natural settings, or other areas with unique or highly-valued environmental or cultural features.

Evaluation Strategy: Like the resident population factor, identifying terrestrial sensitive environments for the soil exposure pathway first requires carefully identifying sources and delineating areas of suspected contamination. Generally, to score this factor, some portion of a terrestrial sensitive environment must be on an area of suspected contamination related to the site. The exceptions are habitats of threatened or endangered species, which might be designated on a county-wide basis.

PA Table 7 (page 20 of the PA scoresheets) lists terrestrial sensitive environments for the soil exposure pathway. Identify sensitive environments as part of a unified research task for the surface water, soil exposure, and air pathways. Topographic maps, State Natural Heritage Program offices, and interviews with local officials (fish and game, parks and recreation) are all good sources of information.

Scoring Instructions: For each qualifying terrestrial sensitive environment, assign a value for environment type from PA Table 7. Qualifying environments must (1) appear in PA Table 7, and (2) occur on an area of suspected contamination that is related to the site (except in the case of county-wide habitat designations).

Note that a single environment can be evaluated for multiple designations. For example, a midnight dumping site in a State-designated Natural Area (25 points, PA Table 7) that is also a habitat used by the State-designated threatened snowshoe hare (50 points) and spotted groundhog (50 points), would receive 125 points for the terrestrial sensitive environments factor.

Sum the values for all qualifying environments. Assign the sum as the score for factor #5 (Terrestrial Sensitive Environments) on the soil exposure pathway scoresheet.

SOIL EXPOSURE PATHWAY TARGETS

Factor: Resources

Definition: Use of the resource (land) for commercial agriculture, commercial silviculture, or commercial livestock production or grazing.

Evaluation Strategy: The resources factor accounts for land uses impacted by suspected contamination:

- ! Commercial agriculture.
- ! Commercial silviculture (e.g., tree farming, timber production, logging).
- ! Commercial livestock production or grazing.

The resources factor is assigned a value of 5 if any of the above resource uses are present on an area of suspected contamination associated with the site; otherwise, a zero value is assigned.

Often, extensive analytical data are required to reliably determine whether any of the specified resource uses occur on an area of contamination. Because such data are not usually available at the PA, the resources factor can generally be assigned 5 points as a default measure. This approach is conservative from the scoring perspective (as the maximum value is assigned), has little impact on the pathway and site score, and can potentially save you many hours of research trying to determine whether a particular use qualifies as "commercial."

Scoring Instructions: If any of the resource uses itemized above occurs on an area of suspected contamination associated with the site, assign a score of 5 to factor #6 (Resources) on the soil exposure pathway scoresheet; otherwise, assign a zero value. Alternatively, simply assign the 5 point value as a default measure.

Total Resident Population Threat Targets: Calculate the Resident Population Threat Targets factor category score by summing the scores assigned to factors #2 through 6. Factor scores should appear in only one of the two columns (A or B) depending on whether you scored a suspected release.

**SOIL EXPOSURE PATHWAY
WASTE CHARACTERISTICS
AND
THREAT AND PATHWAY SCORES**

3.5.3 Waste Characteristics

The evaluation of the Waste Characteristics factor category is discussed in Section 3.2.2. The waste characteristics score (WC) that you calculated using PA Table 1 (Section 3.2.2, and page 4 of the PA scoresheets) is applied to the soil exposure pathway without modification. Assign the WC score to factor #7 on the soil exposure pathway scoresheet.

3.5.4 Calculating Soil Exposure Threat and Pathway Scores

Sum the scores assigned to factors #2 through 6 to arrive at the Resident Population Threat Targets score; enter this sum in the box labeled "T." Multiply the scores in the Likelihood of Exposure (LE), Targets (T), and Waste Characteristics (WC) boxes; divide by 82,500; round to the nearest integer; and record the result, subject to a maximum of 100, as the Resident Population Threat score. If your calculated score exceeds 100, assign 100 as the Resident Population Threat score.

The Nearby Population Threat acknowledges that there are likely to be nearby residents who do not qualify as resident population but may, nevertheless, come in contact with areas of contamination and exposed or accessible wastes by traveling to the site. Do not assign a score to the Nearby Population Threat if you gave a zero score to Likelihood of Exposure. Otherwise, score the Nearby Population Threat on the basis of the population within a 1-mile radius of the site. Use the same 1-mile radius total population you evaluated for air pathway population targets (Section 3.6.2), and assign the threat score according to the following table:

Population Within One Mile	Nearby Population Threat Score
< 10,000	1
10,000 to 50,000	2
> 50,000	4

Sum the Resident Population Threat Score and the Nearby Population Threat score. Record the result, subject to a maximum of 100, as the soil exposure pathway score at the bottom of the page. If your calculated score exceeds 100, assign 100 as the pathway score.

3.6 AIR PATHWAY

The PA evaluation of the air pathway requires you to consider and assign scores to factors in three factor categories: Likelihood of Release, Targets, and Waste Characteristics.

Evaluating likelihood of release requires you to hypothesize whether hazardous substances are likely to be migrating from the site to the air.

The principal threat under the air pathway is the threat of airborne releases of hazardous substances. The targets evaluation is primarily concerned with identifying and evaluating the human population within the 4-mile target distance limit (radius) around the site, and sensitive environments within ½ mile.

The evaluation and score for the waste characteristics factor category (WC, Section 3.2.2) applies directly to the air pathway, as to all other pathways, except if primary targets are identified (Section 3.6.3).

AIR PATHWAY LIKELIHOOD OF RELEASE

3.6.1 Likelihood of Release

Evaluating the Likelihood of Release factor category requires a professional judgment, based on site and pathway conditions, as to whether it is likely that release of a hazardous substance to the air could be detected. This differs somewhat from the way you evaluate Likelihood of Release for the ground water and surface water migration pathways, where you make a professional judgment as to whether a release is likely to have occurred.

As with releases to the other migration pathways, a PA hypothesis of a suspected air release is tested through analytical sampling of environmental media for sites that progress to an SI. However, air releases are fundamentally different from releases to ground water or surface water. Hazardous substances released to ground water may be detected in samples taken long after the release occurred. Likewise, hazardous substances released to surface water may adsorb to sediments and thus remain detectable for long periods. In contrast, because of the rapid dispersion of released substances in the atmosphere, air releases can usually be detected only while the release is occurring. In this sense, the detectability of an air release is transient. Even if the likelihood that a release has occurred is very high, for this pathway it is the likelihood that the release can be detected during SI sampling that is more important.

Likelihood of Release is scored on the basis of one of two scenarios, "Suspected Release" or "No Suspected Release," either of which require you to make a professional judgement as to whether a release is or is not likely to be detected.

Criteria List for Suspected Release to the Air Pathway

The Criteria List suggests a number of characteristics of the site and its environs to consider in developing a hypothesis as to whether an air release might be detected. Answer the questions in the left-hand column of the Criteria List, which deal with a suspected release. Unlike the other migration pathways, a suspected release to the air is sufficient, in itself, to identify primary targets. Consequently, there is no Criteria List for air pathway primary targets.

Carefully consider each element on the Criteria List within the context of the site and its environs. Answers to every question on the list, however, are unlikely to be available for many sites. You need not spend excessive amounts of time trying to develop detailed information to respond to each question -- it is possible to arrive at a sound hypothesis about suspected releases without knowing answers to all questions on the list.

Also, keep in mind that because there is an infinite variety of site-specific circumstances, no list of this type could identify every characteristic that might apply to any specific site. The list, therefore, is by no means complete and the criteria making up the list are not prioritized in any way. Instead, these questions are meant to get you thinking about the types of site-specific conditions that need to be considered when formulating a hypothesis about a suspected release. There are likely to be other site-specific criteria that apply to a particular site, and you are encouraged to think along these lines. If such additional considerations enter into your conclusions, identify them at the bottom of the list.

Answer the questions on the list by checking the appropriate box marked "yes," "no," or "unknown." In evaluating each question, rely on the total body of information you have obtained about the site and its environs through the course of your investigation -- file searches, desktop data collection, site reconnaissance, interviews, etc.

AIR PATHWAY LIKELIHOOD OF RELEASE

Answers to many of the individual questions are likely to be fairly self evident. The difficult part lies in drawing the final conclusion, which amounts to a hypothesis as to whether you suspect a release, and whether that release is likely to be detectable during an SI. This requires professional judgment, and is a somewhat intuitive process that relies upon your accumulated professional expertise and specific knowledge of site conditions and characteristics. Note that the Criteria List is not a tally sheet requiring a majority of "yes" or "no" answers to come to a particular conclusion. You may hypothesize a suspected release on the basis of one or more considerations that lead you to believe there is a relatively high likelihood of detecting hazardous substances released to the air.

Suspected Release Considerations

Each item on the Criteria List for suspected release to the air is briefly discussed below.

Are odors currently reported?

Reports of odors from the site may indicate that hazardous substances are being released to the air. Such reports may come from employees, if the site is active, or from nearby residents. The local Department of Health may have received complaints of odors, or you may obtain such reports while interviewing site representatives and neighbors. Be aware of odors yourself during your site reconnaissance. If you undertake an onsite reconnaissance, health and safety rules require you to conduct continuous air monitoring with HNu, OVA, or similar instrumentation; abnormal readings from these instruments, even if you don't smell anything, could also be indicative of a release. When evaluating odors, keep in mind the characteristics and operational history of the site itself. Some sites -- landfills, for example -- typically smell unpleasant, and odor alone may not be sufficient cause to suspect a release of hazardous substances.

Has release of a hazardous substances to the air been directly observed?

Direct observation of a release to the air might occur under circumstances where hazardous substances are suspected to be present in particulate form (e.g., mine tailings, waste pile) or adsorbed to particulates (e.g., contaminated soil), and site conditions (e.g., dry, dusty, windy) favor air transport. For example, facility employees or neighbors may report dust clouds from the site when the wind is high, or you may observe such a condition during your reconnaissance.

Are there reports of adverse health effects potentially resulting from migration of hazardous substances through the air?

The local Health Department, facility employees, or neighbors may have reported health effects such as headaches, nausea, or dizziness that could lead to a hypothesis that releases are occurring. Should you experience such symptoms yourself during the site reconnaissance, health and safety considerations require you to leave the area immediately. Such an experience would be a strong reason to hypothesize a release.

Does analytical or circumstantial evidence suggest a release to the air?

Other evidence of release to the air might include conditions such as dead or stressed vegetation that doesn't appear to have been affected by direct deposition or overland migration of hazardous substances, reports from neighbors of any type of airborne particulate

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"fallout" that might have originated at the site, faded paint or etched glass on the automobiles in the facility's parking lot, and so forth.

After answering these questions, and adding other considerations to the list, indicate your professional judgment as to the likelihood of detecting a release of hazardous substances to the air by checking "yes" or "no" next to the "Release Suspected?" question. Remember that this is a judgment call; you don't need a majority of "yes" responses -- in some cases, a single "yes" may be sufficient to suspect a release. Summarize the rationale for your hypothesis.

Scoring Likelihood of Release

After completing your evaluation of the Criteria List for releases to the air, you should have a hypothesis as to whether you do or do not suspect that a release may be detectable. The following pages explain how to assign a score to the Likelihood of Release factor category, depending on whether your hypothesis is "Suspected Release" or "No Suspected Release."

**AIR PATHWAY
LIKELIHOOD OF RELEASE**

Factor: Suspected Release

Definition: A professional judgment conclusion based on site and pathway conditions indicating that release of a hazardous substance to the air is likely to be detected.

Evaluation Strategy: In scoring a suspected release, you are stating a hypothesis that it is likely that a hazardous substance from the site could be detected in a release to the air. For PA purposes, your professional judgment is usually based on indications -- which is not the same as documented fact. Remember, however, that detecting an air release with environmental samples during an SI is often more difficult than detecting a release to ground water or surface water. Your judgment regarding a suspected air release must include consideration of the ability to detect such a release.

The Criteria List for air releases (discussed on pages 126 to 128) helps guide the process of considering pertinent conditions that might lead you to suspect a release.

Scoring Instructions: Hypothesize and score a suspected release when available information leads you to conclude that there is a relatively high likelihood of detecting a hazardous substance released to the air. Assign a score of 550 to factor #1 (Suspected Release) on the air pathway scoresheet (page 22 of the PA scoresheets); assign the score under Column A, and use only Column A for the air pathway. Do not assign a score to factor #2 (No Suspected Release).

If you do not hypothesize a suspected release, score factor #2 (No Suspected Release).

**AIR PATHWAY
LIKELIHOOD OF RELEASE**

Factor: No Suspected Release

Definition: A professional judgment conclusion based on site and pathway conditions indicating that release of a hazardous substance to the air is not likely to be detected.

Evaluation Strategy: If you did not hypothesize a suspected release from your evaluation of the Criteria List, then your hypothesis must be that a release is not suspected. You must complete an evaluation of the Criteria List before concluding that no release is suspected.

Just as a hypothesis that a release is suspected is based on conditions at and around the site, so is the hypothesis that a release is not suspected. In this instance, however, available information leads you to conclude that there is a relatively low likelihood that a hazardous substance is being released to the air, or that any releases that may occur are so transient or rapidly dispersed that it is unlikely that a release could be detected through sampling during an SI.

Scoring Instructions: If you do not suspect a release to air, assign a score of 500 to factor #2 (No Suspected Release) on the air pathway scoresheet. Assign the score under Column B and use only Column B for the air pathway.

3.6.2 Targets

Target populations under the air pathway consist of people who reside, work, or go to school within the 4-mile target distance limit around the site. PA air pathway targets also include sensitive environments and resources.

Targets are evaluated on the basis of their distance from the site. To assist in this evaluation, draw a series of concentric circles on your topographic map with radii of ¼ mile, ½ mile, 1 mile, 2 miles, 3 miles, and 4 miles from the site.

Residential Populations

Identify the residential population onsite and in each of the six distance categories around the site. Automated electronic databases are very useful for this purpose. The Graphical Exposure Modeling System (GEMS) is one such database. GEMS was developed for, and is maintained by, EPA's Office of Toxic Substances. If direct access to GEMS is not available through your office, contact the EPA Regional office to arrange access and to find out about other databases of population information.

GEMS works with U.S. Bureau of the Census population data. You provide, as input, the latitude and longitude coordinates for the site, and specify the six distance radii (in kilometers). GEMS returns the residential population in each distance category.

National Planning Data Corporation (NPDC, Ithaca, NY) maintains a similar database that uses U.S. Census data updated to account for population growth and new development. For a fee, NPDC can also provide population data.

The Bureau of the Census has developed Topographically Integrated Geographic Encoding and Referencing (TIGER) data files for use as a base map for the 1990 census. These may be available for access late in 1991 and will constitute the most accurate and authoritative of electronic population databases.

GEMS and NPDC data are based on populations within "census tracts," which are irregular in size, depending on local population density. Populations are assigned to the centroid of each tract. Thus, if the population centroid for a given tract lies within one of the specified distance categories, GEMS or NPDC reports the entire population of that tract as being in that distance category, even if the census tract itself falls only partially in that distance category. Consequently, populations for specific distance categories may be over- or underestimated. This is of particular concern for the smaller, close-in distance categories -- especially in non-urban, sparsely populated areas. The more distant categories cover much larger areas which are less sensitive to over- or underestimation; population totals reported by GEMS or NPDC for these categories are subject to less error than the areally smaller distance categories.

Populations reported by GEMS or NPDC for distance categories beyond ½ mile can usually be accepted as sufficiently accurate for PA purposes. There may be occasional instances where the population reported by the database clearly doesn't "fit" with your existing knowledge of the area around the site and, in these cases, you may feel it appropriate to obtain an alternative estimate from other sources. However, note from PA Table 8 (page 23 of the PA scoresheets) that, for distance categories of ½ to 1 mile and beyond, large populations are required to score significant secondary target population points, and the population ranges used for scoring purposes are quite wide. The large numbers and wide ranges work to smooth errors in estimation. Consequently, the

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populations reported by GEMS or similar databases for these distance categories should be adequate, and it may not be time-efficient to pursue alternative estimates.

For the close-in distance categories -- onsite, 0 to ¼ mile, and ¼ to ½ mile -- it is a good practice to supplement the information received from databases with house counts from topographic maps, aerial photographs, a windshield survey, or some combination of these methods. For apartments or condominiums, contact the building superintendent or leasing/sales agent to obtain the number of residential units in the building. Obtain the county average figure for persons per household (from U.S. Bureau of the Census data) and multiply this average by the number of counted residences to obtain the population total. For primary target populations, round the average up to the next integer before multiplying; for secondary target populations, round up to the next integer only after multiplying. For onsite residences, count houses during the site reconnaissance and, if your supervisors concur, interview residents to obtain an exact population.

Worker and Student Populations

Because available electronic databases do not provide worker and student populations, identifying these populations is inherently more difficult. Any attempt to fully identify such populations throughout the target distance limit would be time consuming. For these reasons, it is usually best to limit your evaluation of workers and students to readily available information.

From PA Table 8, note the population values assigned to the indicated population ranges according to distance category. For distances beyond ½ mile, very large populations are required to achieve significant point values. For this reason, it is usually not time-efficient to evaluate workers and students in these distance categories unless there are specific, readily-identifiable institutions (e.g., major industrial facility, large university) that may, individually, account for thousands of workers or students.

For distances less than ½ mile, you may want to perform a somewhat more comprehensive survey of workers and students. Most types of schools are identified on topographic maps and local street maps. School enrollment figures can be obtained by contacting school administrators. You may want to obtain worker counts from specific, large businesses, but a complete canvass of employers within ½ mile would not usually be reasonable. In the interest of time-efficiency, again let the population values in PA Table 8 guide the amount of effort to expend.

Sensitive Environments

Identify all sensitive environments, both terrestrial and aquatic, on the site, within ¼ mile of the site, and between ¼ and ½ mile of the site. During the PA, it is not usually necessary to evaluate sensitive environments between ½ mile and the 4-mile target distance limit because distance weights render their contribution to the site score minimal. Be aware that the surface water and soil exposure pathways also require you to identify and evaluate sensitive environments, so a comprehensive survey to meet the scoring needs of each pathway should be conducted as a unified task.

Definition: Sensitive Environment -- A terrestrial or aquatic resource, fragile natural setting, or other area with unique or highly-valued environmental or cultural features.

Typically, areas that fall within the definition of "sensitive environment" are established and/or protected by State or Federal law. Examples include National Parks, National Monuments, habitats of threatened or endangered species, and wildlife refuges. PA Table 5 (page 16 of the PA scoresheets) lists qualifying sensitive environments.

Many types of sensitive environments are identified and labeled on topographic maps, and this is the best place to begin your survey. Telephone interviews with local fish and game officials, and parks and recreation officials, can also be fruitful. Many States also fund a Natural Heritage Program that inventories and provides information on sensitive environments, recreational areas, natural resources, and so forth. These can be excellent sources of information, but should not be your only source. The Natural Heritage Program is usually housed in the State Department of Natural Resources, or similar State agency.

Some sensitive environments cover large areas (e.g., State Wildlife Refuge) and may span, for example, both the 0 to ¼-mile and ¼- to ½-mile distance categories. In these cases (except for wetlands, which are discussed separately below), evaluate the environment only for its closest occurrence to the site; in the example given here, evaluate the refuge only for its occurrence in the 0 to ¼-mile category.

PA Table 5 lists several types of habitat used by State- or Federally-designated endangered or threatened species. Very often, Natural Heritage Programs and other authorities report habitats on a county-wide basis. You may find that a more specific location to answer the question "Is it present on the site, within ¼ mile of the site, or within ½ mile of the site?" is not available. Under such circumstances, it is best to assume that it is present in all three categories, and score it accordingly; that is, score it as present on the site, but not for its presence in the ¼- or ½-mile distance categories.

Probably the most common type of sensitive environment is the wetland. 40 CFR 230.3(t) provides EPA's wetland definition:

Definition: Wetland -- An area that is sufficiently inundated or saturated by surface or ground water to support vegetation adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Many wetlands are identified on topographic maps by the "swamp symbol," but the maps may not show all wetlands. It is a good practice to supplement the topographic map with Wetlands Inventory Maps, which are produced by the U.S. Fish & Wildlife Service and are available either directly from them or from the State or local agency with fish and wildlife responsibilities. The U.S. Army Corps of Engineers, which has responsibilities pertaining to issuing permits to dredge or fill wetlands and waterways, can also be helpful in identifying wetlands.

Measure the total wetlands acreage in each of the following three categories: onsite, 0 to ¼ mile from the site, and ¼ to ½ mile from the site. Assign a wetlands area value from PA Table 9 (page 23 of the PA scoresheets) to each of these acreage totals; for scoring purposes, each of these acreage totals represents a separate environment.

You may encounter situations where two or more sensitive environments overlap to various degrees. Consider, for example, a 10-acre wetland 2,000 feet from the site, located in a State

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Wildlife Refuge, in a county that is designated as critical habitat for the Federally-designated endangered northern spotted owl. In this example, three sensitive environments overlap: the wetland (25 points, PA Table 9), the refuge (75 points, PA Table 5), and the critical habitat (100 points, PA Table 5). If, rather than a county-wide designation, the refuge itself is specifically designated as critical habitat for the owl, the refuge would be assigned a total of 175 points (75 for being a State Wildlife Refuge, plus 100 for being a specifically-designated critical habitat), and the wetland 25 points.

Primary Targets

Like the other migration pathways, a release must be suspected in order to score primary targets for the air pathway. Releases to the air pathway, however, are fundamentally different from releases to the other migration pathways. Depending on the wind, air releases may disperse in any direction. During an SI, primary target hypotheses are tested via analytical sampling, and all populations and sensitive environments out to and including the furthest distance category in which the release can be documented are evaluated as primary targets.

For these reasons, there is no Criteria List for air pathway primary targets (page 21 of the PA scoresheets). Instead, when a release is suspected during the PA, all populations and sensitive environments out to and including the ¼-mile distance category are evaluated and scored as primary targets. Because air releases are usually quickly diluted in the atmosphere, targets beyond the ¼-mile distance are evaluated as secondary targets.

As with the other migration pathways, when a release is not suspected, all targets are evaluated as secondary targets.

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Factor: Primary Target Population

Definition: The human population most likely subject to exposure from release of a hazardous substance to the air.

Evaluation Strategy: If you suspect a release to the air, those persons closest to the site are most likely to be affected and are evaluated as primary targets. When you suspect a release to the air, evaluate and score the residential, student, and worker population within $\frac{1}{4}$ mile as the primary target population.

Scoring Instructions: Evaluate air pathway primary target population only when you suspect a release to the air. If your evaluation of the Criteria List for air releases led you to conclude that a release is not suspected, assign a zero score to factor #3 (Primary Target Population). Otherwise, determine the population within $\frac{1}{4}$ mile as described on pages 131 to 132. GEMS, or a similar electronic database, may be used as a starting point but may not be accurate enough for population evaluations in the close-in distance categories. Database populations should be supplemented by a house count within $\frac{1}{4}$ mile of the site.

During your site reconnaissance, determine the number of people regularly present on the site as residents, students, or workers. Perform a house count within the $\frac{1}{4}$ -mile distance category by examining topographic maps and/or aerial photographs, if they are up to date. Otherwise, conduct a windshield survey as part of your site reconnaissance. The windshield survey will also help identify large apartment or condominium buildings or complexes; obtain the number of units in each by interviewing building superintendents or leasing/sales agents. Determine total residential population by multiplying the number of counted residences by the U.S. Bureau of the Census average number of people per household in the county (round the average up to the next integer before multiplying). The windshield survey, coupled with examining topographic and local street maps, will also identify schools and specific large businesses that may warrant evaluation for student or worker populations (see page 132 for more discussion).

Sum the number of residents, students, and workers identified onsite and within $\frac{1}{4}$ mile of the site. Enter this total on the blank by factor #3 (Primary Target Population) on the air pathway scoresheet (page 22 of the PA scoresheets). Multiply the total by 10, and record the resulting factor score under Column A.

AIR PATHWAY TARGETS

Factor: Secondary Target Population

Definition: The human population less likely to be subject to exposure from release of a hazardous substance to the air.

Evaluation Strategy: If you suspect a release to the air, the residential, student, and worker population onsite and within $\frac{1}{4}$ mile of the site is evaluated as the primary target population; the residential, student, and worker population between $\frac{1}{4}$ mile and 4 miles is evaluated as the secondary target population. If you do not suspect a release, the residential, student, and worker population within the entire 4-mile target distance limit is evaluated as the secondary target population.

Scoring Instructions: Identify residential, student, and worker population as discussed on pages 131 to 132 and in conjunction with the "Evaluation Strategy" for primary target population (page 135). Use GEMS or other electronic databases as a starting point. GEMS or similar data for distances beyond $\frac{1}{2}$ mile are usually acceptable. However, you should supplement the database populations with house counts within $\frac{1}{2}$ mile of the site. Use topographic maps, local street maps, and a windshield survey to perform and/or supplement the house count, and to identify specific large business or educational institutions where worker or student populations may be sufficiently large to warrant investigation.

Sum the residential, student, and worker populations to obtain individual totals for the following distance categories: onsite, 0 to $\frac{1}{4}$ mile, $\frac{1}{4}$ to $\frac{1}{2}$ mile, $\frac{1}{2}$ to 1 mile, 1 to 2 miles, 2 to 3 miles, 3 to 4 miles. From PA Table 8 (page 23 of the PA scoresheets), for each distance category:

- 1) Enter the total secondary target population for the distance category in the "Population" column.
- 2) Working horizontally across the table, circle the value in the same row that represents the range that the distance-category population falls in.
- 3) Record the circled value in the same row of the "Population Value" column.

Sum the population values in the right-hand column. Record this total at the bottom of the column and in one of the blanks for factor #4 (Secondary Target Population) on the air pathway scoresheet. Use the blank under Column A if you scored a suspected release for the Likelihood of Release factor category; use Column B if not.

Factor: Nearest Individual

Definition: The person closest to any source at the site.

Evaluation Strategy: The distance to the nearest individual is an indicator of the magnitude of the threat the site poses to the person most likely to be exposed to hazardous substances that may be released from the site. All other considerations being equal, the closer a person is to the site, the higher the threat that the person might be exposed to hazardous substances.

The nearest individual is represented by the nearest regularly occupied building -- you need not locate or obtain the identity of an actual person. The nearest regularly occupied building could be a building on the site itself, or it could be a nearby residence, workplace, school, church, etc.

Annotate the topographic map to identify the nearest regularly occupied building. Use a ruler or pair of dividers to determine the shortest straight-line distance between it and any source at the site. If the distance is so short as to make map measurement impractical, estimate the distance through visual observation during the site reconnaissance. Record this distance in the "Pathway Characteristics" box on the air pathway scoresheet; record an absolute number, not a range, accurate within a margin of ± 100 feet.

Scoring Instructions: If you have identified any primary target population you have, in effect, hypothesized that the threat or likelihood of exposure is relatively high. For this reason, whenever a primary target population is present, assign a score of 50 to the Nearest Individual factor, regardless of distance. Assign the score under Column A.

Otherwise, from PA Table 8 (page 23 of the PA scoresheets), select the distance category in which the nearest regularly occupied building is located (far-left column). Circle the value on the same line in the column labeled "Nearest Individual." Record the selected value in one of the blanks for factor #5 (Nearest Individual) on the air pathway scoresheet. Use the blank under Column A if you scored "Suspected Release" for the Likelihood of Release factor category; use the blank under Column B if you scored "No Suspected Release."

AIR PATHWAY TARGETS

Factor: Primary Target Sensitive Environments

Definition: Sensitive environments most likely subject to exposure from release of a hazardous substance to the air.

Evaluation Strategy: Identify all sensitive environments on and within $\frac{1}{2}$ mile of the site (pages 132 to 134) as part of a unified task to identify sensitive environments for the air, soil exposure, and surface water pathways.

If you suspect a release to the air, those sensitive environments closest to the site are most likely to be affected and are evaluated as primary targets. Therefore, if you suspect a release to the air, evaluate and score all sensitive environments on or within $\frac{1}{4}$ mile of the site as primary sensitive environments.

Scoring Instructions: Evaluate air pathway primary target sensitive environments only when you suspect a release to the air. In the box under factor #6 (Primary Sensitive Environments) on the air pathway scoresheet, list all sensitive environments on or within $\frac{1}{4}$ mile of the site. From PA Table 5 (page 16 of the PA scoresheets), assign values for each environment type. In the case of wetlands, assign values for wetland area (PA Table 9, page 23 of the PA scoresheets). Sum these values and record the result as the factor score for primary target sensitive environments. Record the score under Column A.

If your evaluation of the Criteria List for air releases led you to conclude that a release is not suspected, assign a zero score to factor #6.

Factor: Secondary Target Sensitive Environments

Definition: Sensitive environments less likely subject to exposure from release of a hazardous substance to the air.

Evaluation Strategy: Identify all sensitive environments on and within $\frac{1}{2}$ mile of the site (pages 132 to 134) as part of a unified task to identify sensitive environments for the air, soil exposure, and surface water pathways.

If you suspect a release to the air, all sensitive environments on or within $\frac{1}{4}$ mile of the site are scored as primary sensitive environments; those between $\frac{1}{4}$ and $\frac{1}{2}$ mile are scored as secondary sensitive environments. If a release is not suspected, all sensitive environments on or within $\frac{1}{2}$ mile of the site are scored as secondary sensitive environments.

Scoring Instructions: From PA Tables 5 and 9 (pages 16 and 23 of the PA scoresheets) assign a value for each secondary sensitive environment. Turn to PA Table 10 (page 23 of the PA scoresheets) and list each environment by distance category, along with its associated value. Remember that, except for wetlands, sensitive environments that span two or more distance categories are evaluated only for their closest occurrence to the site. For wetlands, the acreage occurring in each distance category is evaluated separately. Multiply each environments' value by the distance weight given in PA Table 10, and record the product in the right-hand column. Sum the values in the right-hand column; record the total at the bottom of the column and as the score for factor #7 (Secondary Sensitive Environments) on the air pathway scoresheet. Record the score under Column A if you scored a suspected release for the Likelihood of Release factor category; under Column B if you did not.

AIR PATHWAY TARGETS

Factor: Resources

Definition: Use of land around the site for commercial agriculture, commercial silviculture, or recreation.

Evaluation Strategy: The resources factor accounts for land uses around the site that may be impacted by a release to the air:

- ! Commercial agriculture.
- ! Commercial silviculture (e.g., tree farming, timber production, logging).
- ! Major or designated recreation area (e.g., municipal swimming pool, campground, park).

The resources factor is assigned a value of 5 if any of the above resource uses are present within ½ mile of any source at the site; otherwise, a zero value is assigned.

Because agriculture, silviculture, or recreation uses are often present, the resources factor can generally be assigned 5 points as a default measure. This approach is conservative from the scoring perspective (as the maximum value is assigned), has little impact on the pathway and site score, and can potentially save you many hours of research trying to determine whether a particular use qualifies as "commercial" or "major or designated."

Scoring Instructions: If any of the resource uses itemized above are present within ½ mile of any source at the site, assign a score of 5 to one of the blanks for factor #8 (Resources) on the air pathway scoresheet; otherwise, assign a zero value. Alternatively, simply assign the 5 point value as a default measure. Use the blank under Column A if you scored a "Suspected Release" for the Likelihood of Release factor category; use the blank under Column B if you scored "No Suspected Release."

Total Targets: Calculate the Targets factor category score by summing the scores assigned to factors #3 through 8. Factor scores should appear in only one of the two columns (A or B) depending on whether you scored a suspected release.

**AIR PATHWAY
WASTE CHARACTERISTICS
AND
PATHWAY SCORE**

3.6.3 Waste Characteristics

The evaluation of the waste characteristics factor category is discussed in section 3.2.2.

If you have identified any primary target population or primary target sensitive environment, assign either the waste characteristics score (WC) that you calculated using PA Table 1 (Section 3.2.2, and page 4 of the PA scoresheets) or a score of 32 -- whichever is greater -- to factor #9a. Assign this score under Column A. Do not evaluate factor #9b.

If you have not identified any primary target population or primary target sensitive environment, assign the waste characteristics score (WC) that you calculated using PA Table 1 (Section 3.2.2, and page 4 of the PA scoresheets) to factor #9b. Assign the score under Column A if you scored "Suspected Release" for likelihood of release; under Column B if you scored "No Suspected Release." Do not evaluate factor #9a.

3.6.4 Calculating the Air Pathway Score

The air pathway scoresheet is organized by the three factor categories: Likelihood of Release (LR), Targets (T), and Waste Characteristics (WC). Enter the score for either Suspected Release (factor #1) or No Suspected Release (factor #2) into the box labeled "LR." Sum the Target scores (factors #3 through 8) down the appropriate column and record the sum in the box labeled "T." Enter the Waste Characteristics, score (factor #9a or 9b) into the box labeled "WC." All scores should appear in either Column A or Column B, depending on your evaluation of Likelihood of Release.

Multiply LR x T x WC; divide the product by 82,500; round to the nearest integer; and record the result, subject to a maximum of 100, as the air pathway score at the bottom of the page. If your calculated score exceeds 100, assign 100 as the pathway score.

3.7 SITE SCORE AND SUMMARY

Calculate the site score by filling in the matrix at the top of page 24 of the PA scoresheets. Record each pathway score in the appropriate box under the column labeled "S." Square each pathway score, and record the result in the appropriate box under the column labeled "S²." Sum the four S² values; divide the sum by 4, take the square root of the result, round to the nearest integer, and record the result as the site score.

Answer the questions on page 24 of the PA scoresheets; these summarize important conclusions of the PA.

The questions ask for a qualitative evaluation of the relative risk of targets being exposed to hazardous substances from the site. You may find your responses to these questions a good cross-check against the way you scored the individual pathways. For example, if you scored the ground water pathway on the basis of no suspected release and secondary targets only, yet your response to question #1 is "yes," this presents apparently conflicting conclusions that you need to reconsider and resolve. Answers to the questions on page 24 should be consistent with your evaluations elsewhere in the PA scoresheets package.

For affirmative responses regarding high risk to targets, the questions also ask you to identify specific targets. This information will be useful for next-step planning purposes. Attach additional pages if necessary.